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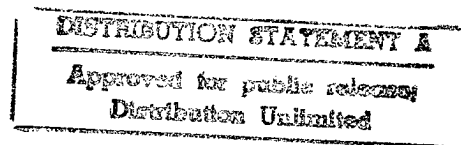
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JPRS Report

Science & Technology

USSR: Space

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Science & Technology

USSR: Space

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Chronology of Cosmonaut Flight on 'Mir' Complex (26 Sep 87 - 24 Nov 87)

'Progress-32' Docks With 'Mir' Complex

18660042 Moscow IZVESTIYA in Russian
27 Sep 87 p 1

[Text] The cargo spaceship "Progress-32" docked with the manned complex "Mir" on 26 September 1987, at 0508 hours Moscow time.

The mutual search, rendezvous, approach and docking were carried out with the aid of onboard automation. These procedures were monitored by the Flight Control Center interacting with the ground command-and-measurement complex, and also by cosmonauts Romanenko and Aleksandrov.

The "Progress-32" ship docked with the complex at the end where the "Kvant" module is located. Fuel for the station's combined engine unit, foodstuffs, water, equipment and instruments, and also mail were delivered into orbit.

According to telemetry data and the crew's reports, the onboard systems of the manned complex "Mir" are functioning normally.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

Cosmonauts Begin Unloading 'Progress-32'

18660042 Moscow IZVESTIYA in Russian
30 Sep 87 p 1

[TASS Report]

[Text] Flight Control Center, 29 September. Yuriy Romanenko, commander of the crew of the scientific research complex "Mir", has been working in near-Earth orbit for 235 days, and flight engineer Aleksandr Aleksandrov is completing the 10th week of his tour of duty in space.

Since the arrival of the unmanned transport spaceship "Progress-32", the cosmonauts have been engaged chiefly in unloading it and placing equipment that it delivered in the complex.

Today's agenda calls for carrying out routine preventive maintenance measures on board the station and performing a number of technical experiments.

Calibration and adjusting of instruments of the orbiting observatory "Rentgen" are continuing within the framework of the international program of astrophysical research. For this purpose, the observatory's telescopes have been aimed at the Crab nebula.

According to the crew's reports and telemetry data, the flight of the manned complex "Mir" is proceeding normally.

Cosmonaut Romanenko Surpasses Flight Duration Record

18660042 Moscow PRAVDA in Russian 3 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 2 October. Yuriy Romanenko and Aleksandr Aleksandrov are continuing their work on board the scientific research complex "Mir". The crew's commander has begun the 35th week of his tour of duty in space, and he has already surpassed the achievement of Leonid Kizim, Vladimir Solovyev and Oleg Atkov, who in 1984 completed an orbital mission lasting 237 days.

Today the cosmonauts are conducting their latest medical examination, which includes comprehensive studies of the cardiovascular system, including one using the method of ultrasonic detection. Also planned are routine maintenance work on individual units of the station, and training exercises using the stationary bicycle and the running track.

During the past two days the crew was busy unloading the transport spaceship "Progress-32", and they performed a series of technical experiments for perfecting various methods of orienting the orbiting complex.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well. The flight is proceeding in accordance with the designated program.

Cosmonaut Romanenko Experiencing Fatigue

18660042 Moscow IZVESTIYA in Russian 2 Oct 87 p 6

[Article by A. Ivakhnov, special correspondent at the Flight Control Center]

[Excerpt] Pilot-cosmonaut of the USSR Yuriy Romanenko began counting record time in flight on the night of September 30-October 1—around midnight, to be exact.

Up until the last few days, the record for duration of a stay in orbit belonged to Leonid Kizim, Vladimir Solovyev and Oleg Atkov, who were on a space trip for 237 days.

Physicians are concerned most of all about the psychological aspects of the mission and the health of the nervous system of the candidate for a new record. It was easier for his predecessors, since the three of them remained together from the beginning of their mission to the end. This time, a stressful situation occurred; the

module "Kvant" failed to dock properly, and an unplanned egress had to be made into open space. After that, flight engineers were changed while the mission was in full swing.

There is still another circumstance of considerable importance. It was just a few years ago that space medicine specialists reported a conclusion of theirs to journalists: the optimal working time for a human being in orbit is three to four months. One month for adaptation, followed by a period of efficient work. But as time passes, fatigue builds up, working fitness declines, and it is time to think about replacing the crew. As a matter of fact, this is what will happen when prolonged testing ceases to be necessary. If Yuriy Romanenko's mission is measured by this yardstick, then he has now served a double tour of duty in space.

"Fatigue makes itself felt, of course," he related. "For example, I never used to notice noise from the fans at all, but now it sometimes wakes me up at night. Sometimes I don't fall asleep right away in the evening, or I wake up in the middle of the night, and then I'm not myself in the morning. People on the ground already know about these difficulties I'm having, and Sasha Aleksandrov treats me considerably; if I oversleep, they try not to wake me. If I get more tired than usual during the day, I take medicine at night, according to advice from medical personnel."

Biotechnology, Photometer Research on "Mir" Complex

18660042 Kiev PRAVDA UKRAINY in Russian
7 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 6 October. Yuriy Romanenko, commander of the crew of the "Mir" complex, has been working in near-Earth orbit for eight months, and flight engineer Aleksandr Aleksandrov is completing the 11th week of his tour of duty in space.

The cosmonauts are continuing to carry out their research program while unloading the transport spaceship "Progress-32" and carrying out routine preventive maintenance measures on the station. Plans for today call in particular for biotechnology, geophysical and astrophysical experiments, as well as preparation of apparatus for conducting space materials science research.

A series of experiments with the unit "Svetoblok-T" has begun for the purpose of synthesizing a polyacrylamide gel that is necessary for perfecting technology for obtaining biologically active compounds in terrestrial conditions.

With the aid of the electronic photometer EFO-1, the crew will perform several cycles of measuring changes in the brightness of stars as they set beyond the Earth's

atmosphere. This work is being done for the purpose of further studying the atmosphere's structure and obtaining experimental data on layers of dust made up of micrometeoritic matter at an altitude on the order of 100 kilometers.

The flight is proceeding normally.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

Cosmonaut Experiments Study Chemical Reactions in Microgravity

18660042 Moscow IZVESTIYA in Russian
10 Oct 87 p 2

[TASS Report]

[Text] Flight Control Center, 9 October. The latest week of Yuriy Romanenko's and Aleksandr Aleksandrov's tour of duty on board the manned complex "Mir" is ending.

Yesterday the crew was engaged in geophysical, astrophysical and biotechnology research.

A series of experiments for studying dynamics of physical-chemical processes in conditions of extremely small gravitation was begun yesterday in the unit "Biryuza". The cosmonauts carried out a preliminary calibration of this unit's precision thermostat, and today they performed an experiment called "Tsvet". Its purpose is to study mechanisms and features of the formation of three-dimensional structures in the course of fluctuating chemical reactions. The crew observed processes which were occurring and recorded them on color photographic film.

Today's agenda calls also for one more cycle of research of the Earth's atmosphere, using the electronic photometer EFO-1.

Tomorrow will be a day of rest for Yuriy Romanenko and Aleksandr Aleksandrov. They will meet with their families during periods of radio and television communications.

Both cosmonauts are feeling well.

The flight is proceeding in line with the designated program.

Cosmonauts Begin New Cycle of Supernova Observations

18660042 Baku BAKINSKIY RABOCHIY in Russian
14 Oct 87 p 2

[TASS Report]

[Text] Flight Control Center, 13 October. The flight of the orbiting complex "Mir", which is manned by Yuriy Romanenko and Aleksandr Aleksandrov, is continuing.

The latest cycle of studies of the supernova in the Large Magellanic Cloud has begun, following calibration of telescopes of the observatory "Rentgen". The purpose of these observations is to distinguish flows of gamma ray quanta resulting from decay of radioactive cobalt, which is transformed into iron in the supernova's shell. At the same time, a search is being made for radiation of the X-ray pulsar which formed as a result of the star's destruction.

In the courses of astrophysical experiments, highly precise orientation of the orbiting complex for prolonged periods of time is maintained automatically by means of an onboard computer, as well as a platformless inertial system and powered gyroscopic stabilizers installed on the module "Kvant". The crew periodically measures this automatic system's actual degrees of error with the aid of special apparatus and feeds this data into the onboard computer complex, which corrects possible deviations from the specified orientation. This method of orientation makes it possible to ensure aiming of X-ray telescopes at prescribed sources of radiation accurately to within a few minutes or arc. This degree of precision is maintained over the course of a complete 24-hour cycle of observations.

Today's agenda calls also for experiments aimed at further studying dynamics of physical-chemical processes in zero gravity, using the unit "Biryuza", and for routine preventive maintenance work on individual onboard systems.

The functional state of the cosmonauts' cardiovascular systems at rest and during performance of physical exercises with the stationary bicycle was determined in the course of a medical examination of the crew which was conducted yesterday.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well. The work in orbit is continuing.

Cosmonauts Continue Research With 'Rentgen' Observatory and 'Biryuza' Unit

18660042 Moscow PRAVDA in Russian 17 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 16 October. The prolonged orbital flight of Yuriy Romanenko and Aleksandr Aleksandrov on board the manned complex "Mir" is continuing.

The program of work during the days just past included experiments using the international observatory "Rentgen", visual and instrument observations of the Earth's surface, and measures for replacing individual components of the life-support system which have exhausted their service life.

In the course of the day, the crew is to conduct one more experiment in the "Biryuza" unit for the purpose of studying mechanisms and features of the formation of three-dimensional structures in the course of fluctuating chemical reactions. Processes taking place will be recorded with the aid of the video tape recorder "Niva".

According to the results of medical monitoring, both cosmonauts are feeling well. The commander's pulse rate is 62 beats a minute and the flight engineer's is 65 beats a minute, and their arterial pressures are 125 over 75 and 120 over 65 millimeters of mercury, respectively.

The crew was given Saturday and Sunday to rest. The work in orbit is continuing.

Cosmonauts Perform Earth Observations, UV Astronomy Studies

18660042 Moscow PRAVDA in Russian 21 Oct 87 p 1

[TASS Report]

[Text] Flight control Center, 20 October. Yuriy Romanenko has been working in near-Earth orbit for 256 days, and the 13th week of Aleksandr Aleksandrov's tour of duty in space is ending.

Today's agenda for the crew calls for conducting observations and photography of individual areas of land surface and the waters of the world's oceans, for research in the field of extra-atmospheric astronomy, and for two hours of physical exercises.

The latest cycle of experiments for studying astrophysical objects in the ultraviolet wave band has begun. These experiments are being performed with the aid of the telescope "Glazar", which is installed in the "Kvant" module. The purpose of these studies is to obtain data on short-wave length radiation of galaxies. Areas in the constellations Puppis and Andromeda have been selected as objects of observations.

According to results of trajectory measurements, the orbit parameters of the manned complex "Mir" at the present time are: maximum distance from the surface of Earth—354 kilometers; minimum distance from the surface of Earth—305 kilometers; period of revolution—90.9 minutes; inclination—51.6 degrees.

The work in orbit is continuing.

Cosmonauts Continue Observations With 'Kvant' Instruments

18660042 Moscow PRAVDA in Russian 24 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 23 October. The space tour of duty of Yuriy Romanenko and Aleksandr Aleksandrov on board the orbiting complex "Mir" is continuing.

Experiments employing equipment of the specialized module "Kvant" occupy a substantial place in the crew's work. Several sessions of research of astrophysical objects in different wave bands are performed each day. Today the supernova in the Large Magellanic Cloud and individual areas of the constellations Grus and Carina will be photographed with the aid of the ultraviolet telescope "Glazar", and observations of a source of X-radiation in the constellation Cygnus are planned in line with the program "Rentgen".

The day's agenda calls also for biological experiments aimed at determining optimal conditions for cultivation of higher plants in space hothouses, as well as routine maintenance of individual onboard systems.

Tomorrow will be a day of rest for Yuriy Romanenko and Aleksandr Aleksandrov. They will do hygienic cleaning of the complex's living compartments, and meet with their families during periods of radio and television communications.

Both cosmonauts are feeling well.

The flight is proceeding normally.

Cosmonauts Continue Astrophysical Observations

18660042 Moscow KRASNAYA ZVEZDA in Russian 28 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 27 October. Yuriy Romanenko and Aleksandr Laveykin are continuing to perform planned research and experiments on board the manned complex "Mir".

Within the framework of the international program of research in the field of extra-atmospheric astronomy, several more series of measurements of X-radiation of the supernova in the Large Magellanic Cloud were performed during the days just past.

Individual sections of the celestial sphere in the constellations Orion and Ursa Major were photographed, using the ultraviolet telescope "Glazar".

In accordance with the medical monitoring schedule, both cosmonauts underwent thorough examinations of their cardiovascular systems.

Today's program of work on board the station includes astrophysical and geophysical experiments. Time is reserved for carrying out routine preventive-maintenance measures on equipment of the base block's temperature control system.

According to reports of the crew and telemetry data, the work in near-Earth orbit is proceeding in accordance with the designated program.

'Mir' Crew Observes Pulsar, Performs Earth Photography

18660042 Moscow PRAVDA in Russian 31 Oct 87 p 1

[TASS Report]

[Text] Flight Control Center, 30 October. The latest week of work on board the scientific research complex "Mir" is ending.

The flight program during the days just past included astrophysical and geophysical experiments, medical studies, and routine maintenance work with equipment of onboard systems of the base block.

A pulsar in the Large Magellanic Cloud was selected as the object of observations in line with the program of astrophysical research that is being conducted with the aid of the orbiting observatory "Rentgen".

Territories of the Caucasus and the western part of Kazakhstan and the waters of the Caspian Sea were photographed, within the framework of the program for research of Earth natural resources and study of the environment.

Photographing of certain areas of central Kazakhstan is planned for today, as is preventive work with the complex's life-support system.

Results of comprehensive medical examinations which both cosmonauts underwent yesterday indicated that the condition of Yuriy Romanenko's and Aleksandr Aleksandrov's health is good and that they are feeling well.

Cosmonaut Romanenko Completes Ninth Month Aboard 'Mir' Complex

18660042 Moscow TRUD in Russian 7 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 6 November. Soviet cosmonauts Yuriy Romanenko and Aleksandr Aleksandrov are celebrating the anniversary of the October Revolution on board the scientific research complex "Mir". The crew's commander has completed the ninth month of his tour of duty in space, and the flight engineer is in his 108th day of work in orbit.

During the past week, the crew carried out final operations for unloading the unmanned transport spaceship "Progress-32" and filled an emptied compartment of the ship with used equipment. Refilling of fuel tanks of the station's combined engine assembly with fuel and an oxidizing agent was begun.

Plans for today call for transferring drinking water to tanks of the base block, and for observing and photographing individual areas of the Earth's surface.

In the course of studies of the supernova in the Large Magellanic Cloud which were made during the second half of October, a sharp change in the spectrum of X-radiation was recorded. Data obtained with the aid of telescopes of the international observatory "Rentgen", which is installed on the "Kvant" module, provide evidence of rapid clarification of this star's shell. During the days immediately ahead, experiments will be continued for the purpose of obtaining new information on this unique astrophysical object.

A "Red Square—'Mir' complex" television link will be set up on 7 November during the working people's holiday demonstration.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

Experimental Redocking With 'Progress-32'

18660042 Moscow IZVESTIYA in Russian
11 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 10 November. The space tour of duty of Yuriy Romanenko and Aleksandr Aleksandrov on board the scientific research complex "Mir" is continuing.

During the days just past, the cosmonauts completed practically all planned work with the unmanned transport spaceship "Progress-32". The ship's cargo compartment was filled with used equipment, drinking water was transferred to tanks of the complex's base block, and the combined engine assembly was completely refilled with fuel and an oxidizing agent.

In line with the designated program, an experiment was performed today for the purpose of further perfecting methods for carrying out dynamic operations in orbit. New algorithms for controlling the movement of spacecraft were tested in conditions of real flight. These algorithms were developed for the purpose of reducing fuel consumption during processes of mutual search, rendezvousing, approach and docking.

Separation and withdrawal of the cargo ship from the orbiting complex were executed at 0709 hours Moscow time, before this experiment began. Rendezvousing of the spacecraft began when the distance separating them was about 2.5 kilometers, and redocking was accomplished at 0847 hours.

Onboard systems of the "Mir" complex and the unmanned transport spaceship "Progress-32" functioned normally at every stage of the maneuvering.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

The work in orbit is proceeding in accordance with the designated schedule.

Cosmonauts Continue Astronomical Observations, Perform Physical Exam

18660042 Moscow PRAVDA in Russian 14 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 13 November. The latest week of Yuriy Romanenko's and Aleksandr Aleksandrov's work on board the scientific research complex "Mir" is ending.

The crew's program of work during the days just past included chiefly experiments in the field of extra-atmospheric astronomy, as well as geophysical studies. Several more series of measurements of X-radiation of the supernova in the Large Magellanic Cloud were made for the purpose of obtaining new information on the supernova.

Experiments for studying astrophysical objects in the ultraviolet wave band are continuing. Individual sections of the starry sky are being photographed today, using the telescope "Glazar".

In the course of the prolonged orbital flight, medical monitoring is conducted regularly for the purpose of evaluating the condition of the crew's health and forecasting its working fitness. The plan for today calls for a comprehensive examination of the cosmonauts' cardiovascular systems both in conditions of rest and while performing physical exercises on the stationary bicycle.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

The flight of the manned complex "Mir" is continuing.

'Progress-32' Undocks From 'Mir' Complex

18660042 Moscow PRAVDA in Russian 19 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 18 November. Yuriy Romanenko has been on his space tour of duty for 285 days, and Aleksandr Aleksandrov is completing the 17th week of his orbital flight.

Astrophysical and geophysical studies and routine maintenance of individual onboard systems of the complex are on the crew's work program today. Time is reserved also for engaging in physical exercises and for medical monitoring.

Following completion of the program of joint flight, the unmanned transport spaceship "Progress-32" was separated from the manned complex "Mir" on 17 November at 2225 hours Moscow time.

All of the operations that were planned for this period, including unloading, refilling tanks of the base block with fuel and an oxidizing agent and transferring drinking water, were fully completed. A correction of the complex's trajectory of movement was executed with the aid of the cargo ship's engine.

The process of undocking was monitored by specialists of the Control Center and cosmonauts Romanenko and Aleksandrov.

According to telemetry information and reports from orbit, the flight is proceeding normally.

Destructive Re-entry of 'Progress-32'

18660042 Moscow PRAVDA in Russian 20 Nov 87 p 1

[TASS Report]

[Excerpt] Flight Control Center, 19 November. The flight of the unmanned transport spaceship "Progress-32", which was launched into near-Earth orbit on 24 September 1987, has ended.

Today the cargo ship was oriented in space on commands from the Control Center, and its engine was then fired at 0310 hours Moscow time. As a result of braking, the "Progress-32" spaceship went into a descending trajectory, entered the dense layers of the atmosphere, and ceased to exist.

Cosmonauts Yuriy Romanenko and Aleksandr Aleksandrov are continuing their work on board the scientific research complex "Mir".

A substantial place in the flight program is reserved for astrophysical experiments employing equipment of the specialized module "Kvant". Galaxies in whose centers active processes are occurring were studied with the aid

of the ultraviolet telescope "Glazar" during the days just past, and photographing of individual sections of the constellation Triangulum and the Andromeda Nebula is planned for today.

Both cosmonauts are feeling well.

The work in orbit is proceeding according to the designated program.

'Progress-33' Cargo Ship Launched

18660042 Moscow IZVESTIYA in Russian
22 Nov 87 p 1

[Text] In line with the program for further operation of the orbiting scientific research complex "Mir", an unmanned cargo spaceship, "Progress-33", was launched from the Soviet Union on 21 November 1987, at 0247 hours Moscow time.

The purpose of the launching of the spaceship is to deliver materials which become depleted and various cargo items to the manned complex "Mir".

The "Progress-33" ship was placed into an orbit with the parameters: maximum distance from the surface of Earth—268 kilometers; minimum distance from the surface of the Earth—193 kilometers; period of revolution—88.8 minutes; inclination—51.6 degrees.

According to telemetry data, the onboard systems of the unmanned cargo ship are functioning normally.

'Progress-33' Docks with 'Mir' Complex

18660042 Moscow PRAVDA in Russian 24 Nov 87 p 1

[Text] The cargo spaceship "Progress-33" docked with the manned complex "Mir" on 23 November at 0439 hours Moscow time.

The mutual search, rendezvousing, approach and docking were carried out with the aid of onboard automation. These processes were monitored by the Flight Control Center interacting with the ground command-and-measurement complex, and also by cosmonauts Romanenko and Aleksandrov.

The "Progress-33" ship docked with the complex at the end where the "Kvant" module is located. Fuel for the station's combined engine unit, foodstuffs, equipment and instruments, and also mail were delivered into orbit.

According to telemetry data and the crew's reports, the onboard systems of the manned complex "Mir" are functioning normally.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

Cosmonauts Begin Unloading 'Progress-33'

18660042 Moscow IZVESTIYA in Russian
25 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 24 November. The space tour of duty of Yuriy Romanenko and Aleksandr Aleksandrov is continuing.

The latest unmanned transport spaceship—the seventh in a series of cargo ships intended for support of the longest manned mission in the history of cosmonautics—arrived at the orbiting complex "Mir" yesterday. After the seal of the docking mechanism had been checked, the transfer hatches were opened and the crew began unloading equipment that had been delivered.

In addition to working with the "Progress-33" spaceship, the cosmonauts are to perform a number of geophysical studies today. Plans call for visual observations and photographing of individual sections of the Earth's surface, and for experiments aimed at determining optical characteristics of the atmosphere.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

The flight of the orbiting scientific research complex "Mir" is proceeding normally.

FTD/SNAP

/9738

Chronology of Cosmonaut Flight Aboard 'Mir' Complex (28 Nov-20 Dec 87)

Cosmonauts Continue Materials Research, Astrophysical Studies Aboard 'Mir'

18660051 Moscow IZVESTIYA in Russian
28 Nov 87 p 1

[TASS Report]

[Text] Flight Control Center, 27 November—The latest week of Yuriy Romanenko's and Aleksandr Aleksandrov's space tour of duty on board the "Mir" complex is ending.

The crew's program of work during the days just past included space materials-science experiments, geophysical and astrophysical studies, and unloading the "Progress-33" spaceship.

A series of experiments was begun for the purpose of studying features of processes of the melting and crystallization of various materials while being heated by a concentrated flow of radiation. A new technological unit, a mirror-beam furnace, is being used in these studies.

Several series of measurements of flows of high-energy electrons and positrons in near-earth space were made yesterday with the aid of the "Mariya" apparatus.

New data on X-radiation in a wide range of the spectrum, from the center of an active galaxy in the constellation Canes Venatici, has been obtained in the course of astrophysical experiments conducted with the aid of the orbiting observatory "Rentgen."

Today's agenda on board the complex calls for technological experiments, photographing of individual areas of the earth's surface, routine preventive-maintenance work, and physical conditioning exercises.

The flight of the manned complex "Mir" is continuing.

Materials, Botany, Astrophysical Studies on 'Mir' Complex

18660051 Moscow PRAVDA in Russian 2 Dec 87 p 1

[TASS Report]

[Text] Flight Control Center, 1 December—Yuriy Romanenko has been on his space mission for 298 days, and the 12th week of Aleksandr Aleksandrov's work in orbit is ending.

In line with the space materials-science program, the crew performed a number of experiments employing the "Biryuzha" apparatus and the mirror-beam furnace yesterday. Studies were continued of dynamics of physical-chemical processes in zero gravity and features of the melting and crystallization of various materials during heating by a concentrated flow of radiation.

Biological experiments have begun for the purpose of further perfecting methods of cultivating higher plants in space-flight conditions. Studies are being made of the growth and development of arabidopsis and of tissue cultures of this plant in the units "Fiton" and "Bio-term."

Today's agenda on board the "Mir" complex calls for astrophysical, geophysical and technological experiments and for a medical examination of the crew.

For the purpose of studying mechanisms by which high-frequency electrons and positrons are generated in near-earth space, the latest series of measurements of flows of such particles is being made with the aid of the "Mariya" apparatus.

In line with the medical monitoring plan, a study of the condition of the cosmonauts' cardiovascular systems with simulation of hydrostatic pressure will be made this evening. A similar study is being performed with the aid of the pneumatic vacuum suit "Chibis."

According to telemetry data and reports from orbit, the flight of the manned complex "Mir" is proceeding normally.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

Romanenko Passes 300-Day Mark, Work Day Shortened

18660051 Moscow VECHERNYAYA MOSKVA in Russian 3 Dec 87 p 3

[Article by N. Zheleznov, correspondent]

[Excerpt] On the night of 3 December, Yuriy Romanenko, commander of the crew of the orbiting complex "Mir," passed the 300-day mark of his second space mission.

"Basic research of man cannot advance without objective data on permissible limits of vital activity in space," said Academician O. Gazenko, director of the Institute of Medical-Biological Problems.

"And what will we derive, in this connection, from the 301st day of Yuriy Romanenko's space mission?"

"Passing this mark poses no unforeseen threats for us, from all appearances. But we should now proceed wisely and carefully. We need to know precisely when an organism can still 'return' to terrestrial conditions without difficulty or harm.

"On the basis of precisely such considerations, medical personnel recommended that the mission's directors shorten the working day of both Yuriy Romanenko and Aleksandr Aleksandrov (his mission has lasted for more than 4 months) to 4.5 hours."

"To the amount of purely working time which the cosmonauts spend controlling the complex and conducting scientific experiments must be added another 2.5 hours of daily physical exercises and half an hour of daily observations from the complex's windows with recording and sketching of everything seen on earth," related Deputy Flight Director V. Blagov. "The cosmonauts are allotted still another hour for preparing personal programs of activities for the following day before going to sleep."

Cosmonauts Continue Astrophysical Studies, Perform 'Rezonans' Experiment

18660051 Moscow KRASNAYA ZVEZDA in Russian 5 Dec 87 p 1

[Text] Flight Control Center, 4 December—The latest week of Yuriy Romanenko's and Aleksandr Aleksandrov's space tour of duty is ending.

Astrophysical studies employing scientific apparatus of the "Kvant" module occupy a substantial place in the flight program of the manned complex "Mir." On 2 and 3 December, measurements were made, in particular, of X-radiation of a quasar located at a distance of 1.5 billion light years from the earth.

With the aid of the "Mariya" apparatus, several series of experiments were performed for the purpose of studying mechanisms by which particles with high energies are generated in radiation belts of the earth and in near-earth space.

During the days just past, a technical experiment called "Rezonans" was performed for the purpose of determining dynamic characteristics of the orbiting complex and evaluating the size of stresses which affect structures of the complex.

In line with the medical monitoring plan, the cosmonauts conducted an examination yesterday for the purpose of determining bioelectric activity of the heart.

Today's agenda calls for conducting the latest series of astrophysical studies, for monitoring checks and technical maintenance of onboard systems of the complex, and for engaging in physical exercises.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

The flight is proceeding normally.

Cosmonauts Perform Conditioning Exercises With 'Chibis' Vacuum Suit

18660051 Moscow PRAVDA in Russian 9 Dec 87 p 4

[TASS Report]

[Text] Flight Control Center, 8 December—Yuriy Romanenko and Aleksandr Aleksandrov are continuing to carry out the program of the longest manned mission in the history of cosmonautics. The crew's commander has begun the 11th month of his work on board the orbiting complex "Mir."

Today's agenda calls for astrophysical experiments using the orbiting observatory "Rentgen" and the "Mariya" apparatus, for routine preventive-maintenance measures with the television communication system, and for medical examinations.

In addition to engaging in physical exercises with the stationary bicycle and the running track, the cosmonauts will perform conditioning exercises in the pneumatic vacuum suit "Chibis" today. In this suit, a rush of blood to the lower part of the body is created by means of a barometric pressure differential, and terrestrial gravitation is thus simulated.

Yuriy Romanenko and Aleksandr Aleksandrov are feeling well.

The work in orbit is proceeding in line with the designated schedule.

Cosmonauts Named for Crew Rotation on 'Mir'
18660051 Moscow PRAVDA in Russian 10 Dec 87 p 3

[TASS Report]

[Text] Star City (Moscow Oblast), 9 December—The space mission of Yu. Romanenko and A. Aleksandrov is nearing its end. They will soon be replaced on board the orbiting station "Mir" by one of two crews which were introduced to journalists today by General-Major of Aviation A. Leonov, deputy head of the Cosmonaut Training Center imeni Gagarin.

The first crew is headed by Colonel V. Titov, pilot-cosmonaut of the USSR. The flight engineer is M. Manarov, a graduate of the Moscow Aviation Institute. The cosmonaut-researcher is A. Levchenko, a meritorious test-pilot of the USSR. The commander of the second crew of three is Colonel A. Volkov, pilot-cosmonaut of the USSR and a Hero of the Soviet Union; the flight engineer is A. Kaleri, an alumnus of the Moscow Physical-Technical Institute; and the cosmonaut-researcher is A. Shchukin, a test-pilot first class.

Tomorrow, the crews will fly to the Baykonur Cosmodrome, where pre-launch training will begin.

Cosmonauts Unloading 'Progress-33,' Begin Refueling Operations
18660051 Moscow PRAVDA in Russian 16 Dec 87 p 2

[TASS Report]

[Text] Flight Control Center, 15 December—Yuriy Romanenko has been on his orbital mission for 312 days. The 21st week of Aleksandr Aleksandrov's space mission is ending. The crew is unloading the unmanned transport spaceship "Progress-33" and conducting routine preventive-maintenance work while simultaneously continuing to perform planned scientific-technical research.

On 12 December, the cosmonauts began a series of experiments aimed at determining, directly on board the station, the condition of various materials which are exposed to open space. Specimens of structural materials and heat-shielding coatings that are under study are exposed in a hatch compartment. These specimens are inspected with the aid of improved "Elektrotopograf" apparatus.

Astrophysical research employing the ultraviolet telescope "Glazar" is continuing. Individual sections of the celestial sphere near the star Alpha Columbae were photographed yesterday, and the constellation Lepus has been selected as an object for observations today.

The cosmonauts are conducting an experiment with the unit "Svetoblok-T" for the purpose of synthesizing a polyacrylamide gel that is necessary for perfecting technology for obtaining biologically active compounds in terrestrial conditions.

Today's agenda calls also for the latest series of measurements of flows of high-energy particles in near-earth space, and for experiments aimed at determining dynamic characteristics of the intricate orbiting complex.

Refilling of tanks of the base block with fuel and an oxidizing agent has begun in line with the plan of work with the cargo spaceship "Progress-33."

The flight of the manned complex "Mir" is proceeding normally.

'Soyuz TM-4' Moved to Launch Pad at Baykonur
18660051 Moscow PRAVDA in Russian 20 Dec 87 p 1

[TASS Report]

[Text] Baykonur Cosmodrome, 19 December—At dawn today, a complex consisting of a launch rocket and a mated spaceship, "Soyuz TM-4," was moved out of an assembling and testing building and set up on a launching pad of the cosmodrome.

On 21 December 1987, at 1418 hours Moscow time, one of two crews which have completed preparations here for a mission will shoot into near-earth orbit to take the place of Yu. Romanenko and A. Aleksandrov on board the "Mir" station.

General-Lieutenant K. Kerimov, chairman of the state commission, reported to journalists that preparations for launching the spaceship are proceeding without deviation from the timing diagram. The two crews, which are headed by USSR pilot-cosmonauts V. Titov and A. Volkov, have examined and accepted "Soyuz TM-4." Tests of the launch rocket which precede its fueling have already begun.

Telling about the program of the expedition which begins on Monday, K. Kerimov noted that the new crew will spend a week taking over the station from its present crew, in line with this program. Yu. Romanenko and A. Aleksandrov will then return to earth. The cosmonaut-researcher of the new crew will return with them. Test-pilots A. Levchenko and A. Shchukin have been trained for this role. The flight engineer—M. Manarov or A.

Kaleri—will remain with the commander on board the station. On 20 December, the state commission will decide which three-man crew will depart into space.

Destructive Reentry of 'Progress-33'

18660051 Moscow KRASNAYA ZVEZDA in Russian
20 Dec 87 p 1

[TASS Report]

[Text] Flight Control Center, 19 December—The flight of the unmanned transport spaceship "Progress-33," which was launched into near-earth orbit on 21 November 1987, has ended.

The cargo ship docked with the manned complex "Mir" on 23 November. Operations planned for the period of joint flight, including unloading the ship and refueling the station's engine assembly, were fully completed.

The "Progress-33" spaceship was separated from the orbiting complex "Mir" today at 1116 hours Moscow time. The ship was then oriented on commands from the Control Center, and its engine was fired. As a result of braking, "Progress-33" went into a descending trajectory, entered the dense layers of the atmosphere, and ceased to exist.

Cosmonauts Yuriy Romanenko and Aleksandr Aleksandrov were engaged in astrophysical and medical-biological research during the days just past. In line with the plan of preparations for their return to earth, they also conducted the latest conditioning exercises in the pneumatic vacuum suit "Chibis."

Geophysical experiments, damp-mopping of the complex's rooms, and engaging in physical exercises are planned for Yuriy Romanenko and Aleksandr Aleksandrov today. Time is also reserved for rest.

Preparations for launching a spaceship, "Soyuz TM-4," are nearing completion at the Baykonur Cosmodrome. This spaceship and its launch rocket have been set in position in the launching area. Final checks are being made of the space-rocket complex.

The launch of the manned spaceship "Soyuz TM-4" is planned for 21 December at 1418 hours Moscow time.

FTD/SNAP /06091

Work Load of 'Mir' Cosmonauts Reduced

18660019 Moscow TRUD in Russian 2 Oct 87 p 4

[Article by V. Golovachev, special correspondent for TRUD: "Longtime Space Inhabitant: A Report From the Flight Control Center"]

[Text] Kalingrad—No one on earth has flown in space for as long as Yuriy Romanenko, who continues, along with Aleksandr Aleksandrovich, to stand watch aboard

the Mir/Kvant/Soyuz TM-3/Progress-32 orbital complex. Before yesterday, the longest flight beyond the pale of the earth was 237 days—an unparalleled, nearly 8-month voyage completed by the Soviet cosmonauts Leonid Kizim, Vladimir Solovyev, and Oleg Atkov 3 years ago. Romanenko eclipsed that mark yesterday, becoming the first among the longtime inhabitants of space. And if you count his first two flights, the total time Yu. Romanenko has spent beyond the pale of the earth exceeds 340 days. Almost a year in space!

"More than 60 Soviet cosmonauts have spent, all told, 12 man-years in orbit, which is two and a half times more than Western astronauts," the English newspaper TIMES recently wrote.

The length of flight engineer A. Aleksandrovich's space service is a little less. He worked 150 days in orbit with V. Lyakhov in 1983. Nearly 2 1/2 months ago, he replaced A. Laveykin aboard the station, and now he is going on 72 days in his second flight.

The cosmonauts are devoting their attention mainly to astrophysical research. The orbital complex has five telescopes, they must be switched on daily, and the cosmonauts must spend no small amount of time with them.

"Transmit the 'Posledniye izvestiya' [Latest News] to us," Romanenko requested in one of the communications sessions. "With all the things we have had to do, we have lost touch a little with things on earth..."

The crew's request was granted. It was understandable how the cosmonauts missed the earth. Aboard the regularly scheduled Progress-32 transport craft, they received voluminous mail (they always await it eagerly): newspapers, letters from relatives and friends, and a surprise—a big, ripe melon. During the last conversation between the crew members and their families, Romanenko was very interested in all the details of home life—how the repairs his wife was making in the apartment were coming along ("Are the kids helping?" asked Taymir-1), among the many other things. He had left home for the cosmodrome in the dead of winter, in January...

"Will Romanenko's work routine change after he passes the 237-day mark?" journalists asked Deputy Flight Director V.D. Blagov.

"Yes. The doctors recommend that he reduce his work load somewhat. Why, everything beyond that mark is unknown territory, uncharted in practice. How will his body behave? How will he feel, what will his efficiency be, what will his frame of mind be like? Those are not such easy questions when it comes to such a lengthy stay in space.

"Therefore," continued Blagov, "the official working day for the cosmonauts is being shortened for the time being by an hour, and later, possibly, it will be shortened

by 2. Up to now, their working day has been 6 1/2 hours; now it is 5 1/2. I want to point out, that is for both cosmonauts. It would be impossible to give them different work loads, it would not work out. Why, can you imagine one working and the other just looking at him?"

We spoke with various specialists in the Control Center. Most of them agreed that fatigue, as the previous trips have shown, builds up gradually in the cosmonauts on a lengthy space flight. Their output lessens somewhat, their efficiency gets lower, from time to time it becomes difficult to fall asleep after a stressful working day... And that is, of course, understandable—those are not robots on the station, they are normal people engaged in a complex task under difficult and extraordinary conditions.

It would seem that they already have enough to do in orbit. But here come additional "parenthetic" tasks. Now, for example, they receive a multitude of "requests" for greetings from space. Greetings from the cosmonauts to community meeting in the city of Kalingrad absolutely must be made, and still another community cannot manage without the greetings... In the next few days alone, eight (!) greetings are expected from Romanenko and Aleksandrovich. Is that not a bit much? How accustomed we are to the stereotypes, how hearty the old ways are. But why turn the cosmonauts, who are engaged in an extremely important matter, into "wedding generals"? They are going to have to drink of that cup still more when they return to earth...

To practical requests, however, both the cosmonauts and the Flight Control Center respond with great joy. Representatives of the agricultural industry recently went to the center and asked whether, considering this fall's difficult weather conditions, it would be possible to get prompt information on where grain crops were in windrows, how much was threshed, etc. Now these data are going to the agricultural industry in correlated form with a lag of only several days. Prompt information received from space could help to more effectively manage technology and labor resources.

The Flight Control Center's directors immediately agreed, proposing that they would conduct remote surveys, for example, over any of our regions. And in the future, they are prepared to send to the station via the next scheduled trip of the Progress transport craft whatever equipment is necessary.

"And now give us a specific program, assignments, but hurry—the harvest will soon be over," they told the agricultural representatives.

The latter promised to come back with a program.

Here also, by the way, a question arises that needs clarification. For years now, journalists have been told about how interesting work is being done involving the use of space photographs to benefit the national economy. "Reference" fields were photographed at different times and from various altitudes in order to learn to determine the stage of maturation of grain crops, whether they are lodged, whether plants are diseased... But for some reason, this has yet to be put into widespread practice. Specific techniques, programs, and equipment for processing and interpreting photos made from space are needed today. Where is it all? Do we really need 10 years more before these programs are put into practice?

It is believed that economic accountability [khozaschet] will force things to speed up markedly. The Flight Control Center, at least, intends to change over to new management tracks by 1989. Fees will be charged for research and experiments. Today, the make-up of a program often depends on who is allowed to that "pie," who has more "push." The most valuable research and experiments are not at all certain to be included in the program. With the change-over to economic accountability, the situation will most certainly change in a fundamental way...

But that has to do with plans for the future. Right now, the attention of all the service organizations of the center is focused primarily on carrying out the flight program of the "Taymirs." Here they are least of all thinking about records (by the way, for an official record involving the duration of a flight, the prior achievement must be "outdone" by 10 percent, i.e., by 24 days). The main thing is the work. As far as a record goes, that is just incidental...

Cosmonauts today do not have to perform many of the routine operations (orienting the station and controlling it). Computers take care of that. Only once a day do the Taymirs take the controls, to correct small errors in the attitude of the orbital complex. Automatic systems attend to these matters the rest of the time.

The flight continues.

13227/06091

UDC 550.388.2

Photochemistry of Ionospheric D-Region With Injection of Nitrogen Oxides

18660002a Moscow GEOMAGNETIZM I
AERONOMIYA in Russian Vol 27, No 3, May-Jun 87
(manuscript received 6 May 86) pp 383-387

[Article by S.I. Kozlov, Applied Geophysics Institute, USSR State Committee for Hydrometeorology and Environmental Control]

[Abstract] Various aspects of D-region photochemistry at altitudes 60-80 km with the artificial injection of H_2 and H_2O were examined in two earlier studies (S.I. Kozlov, GEOMAGNETIZM I AERONOMIYA, Vol 24, p 723, 1984; S.I. Kozlov, et al., KOSMICH. ISSLED., Vol 20, p 881, 1982) using a universal aeronomic model. A similar study has been made of D-region photochemistry with the injection of NO and NO_2 . The problem is formulated essentially the same as the previous work. Emphasis is on behavior of the medium at relatively short distances from the point of injection of nitrogen oxides and determination of the photochemical processes leading to variations of different parameters. Numerical estimates were made using the same model, first separately for each of the oxides and then for the simultaneous injection of NO and NO_2 ; many of the same initial data were used. It was assumed that the injection of nitrogen oxides does not result in disruption of the atmospheric thermal regime and the spatial and temporal distributions are determined only by diffusion processes. In contrast to the earlier studies, an estimate is made of the influence of diffusional processes on variation of different charged particles and minor neutral atmospheric components. Numerical computations were made to determine the principal mechanisms responsible for variation of electron density and other atmospheric components. A qualitative analysis was made of the influence of diffusion on the distribution of the sought-for parameters, whose role can increase considerably due to the appearance of concentration gradients in the disturbed region. Figures 3; references 6: 4 Russian, 2 Western.

5303/08309

UDC 523.62-72:550.383

Structural Dynamics of High-Latitude Magnetosphere Determined From Solar Electron Data

18660002b Moscow GEOMAGNETIZM I
AERONOMIYA in Russian Vol 27, No 3, May-Jun 87
(manuscript received 14 Apr 86) pp 440-447

[Article by V.A. Sergeyev, S.N. Kuznetsov and Yu.V. Gotselyuk, Nuclear Physics Institute, Moscow State University]

[Abstract] The characteristics of the auroral peak, a specific structure of injections of high-energy solar electrons on the nighttime side of the polar cap, were

investigated for the first time. The study was based on data from the "Interkosmos-17" satellite, which registered leaking electrons with E greater than 30 keV and leaking and trapped electrons with E greater than 8 keV. These data were supplemented by measurements of high-energy electrons by the ISEE-1 satellite and information on magnetic variations and auroras registered by an all-sky camera at Kheys station. All the considered data apply to an interval of registry of extremely strong streams of solar cosmic rays observed on 13-14 February 1978. The analysis revealed that the auroral peak is associated with the leakage of solar electrons on closed lines of force and therefore the boundary of injections of solar electrons on the nighttime side is not the boundary of closed-open tubes of force in the tail of the magnetosphere, as was postulated by L.C. Evans, et al., JGR, Vol 77, p 5580, 1972, and I.B. McDiarmid, et al., JGR, Vol 75, p 3910, 1970, although this does hold true for the daytime sector. The most probable mechanism of auroral peak formation is nonadiabatic scattering of particles in the current sheet. The breakup region and the polar margin of the auroral cusp are linked to the auroral peak region, which is a projection of the part of the current sheet with a low normal magnetic field component. Figures 3; references 14: 10 Russian, 4 Western.

5303/08309

UDC 550.383

Relationship Between Characteristics of Low-Energy Electrons and Geomagnetic Disturbance in Geostationary Orbit

18660002c Moscow GEOMAGNETIZM I
AERONOMIYA in Russian Vol 27, No 3, May-Jun 87
(manuscript received 31 Jul 86) pp 494-496

[Article by O.S. Grafodatskiy, V.I. Degtyarev, A.G. Kozlov, V.I. Lazarev, O.I. Platonov, G.V. Popov and M.V. Teltsov, Nuclear Physics Scientific Research Institute, Moscow State University, Siberian Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Siberian Department, USSR Academy of Sciences]

[Abstract] Measurements of low-energy (0.3-5.0 keV) electrons made on the "Raduga" geostationary satellite during a period of low magnetospheric disturbance in April-September 1980 were analyzed. The spectra of particles in the substorm disturbance region differ from Maxwellian and their fluxes are increased as a result of acceleration of plasma sheet particles from the tail of the magnetosphere in the region $6.6R_E$. The fluxes and spectra of these particles are complexly and strongly dependent on the level of magnetic disturbance and LT. In order to ascertain the relationship between the observed spectra and physical processes in the magnetosphere it was assumed that a magnetospheric disturbance develops in a spatially limited "nucleus" near the midnight meridian and in its expansion forms the

charged particles "injection" front. The results of measurements of electron fluxes were averaged for fixed hourly LT intervals and the diurnal variation of fluxes of electrons of different energies was determined from these averaged values. The effects of local magnetospheric disturbances and the effects of movements of the plasma sheet edge could be separated. In a particularly quiet magnetosphere there were no regions in the neighborhood of the geostationary orbit where electron acceleration could occur; in the quiet magnetosphere small local disturbances can occur; in a slightly disturbed magnetosphere the frequency and intensity of local disturbances increase. Figures 2; references 5: 4 Russian, 1 Western.

5303/08309

Using Nonstationary Models of the Atmosphere to Describe Satellite Drag

18660003 Moscow IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: GEODEZIYA I
AEROFOTOSYEMKA (manuscript received 2 Oct 86)
in Russian No 2, Mar-Apr 87 pp 59-69

[Article by Malkin, O. A., professor, doctor of physical and mathematical sciences, and Lupovka, V. A., graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping, and Cartographic Engineers]

[Abstract] At altitudes below 1,000 km, atmospheric drag severely affects the accuracy of predictions of satellite motions. In terms of drag, nonstationary atmospheric models are substantially more accurate than stationary models for describing satellite motions, particularly over long periods of time. Exploring the possibilities of using simpler models with no loss in accuracy, the authors compared two compact, high-speed, nonstationary models of the atmosphere—the GOST 22721-77 and the DTM—with the more complex and intricate CIRA-72, MSIS-77, and MSIS-83 models and with an analytic version of the J77A model. The authors examined the models in terms of overall atmospheric density at specific levels of solar and geomagnetic activity and at altitudes of 250, 400, and 1,000 km. For the same altitudes, they studied the relationship between density variations and the varying levels of solar activity (70 less than or equal to $F_{10.7}$ less than or equal to 200) and geomagnetic activity (0 less than or equal to K_p less than or equal to 8). Under 700 km, at $F = F = 130$ and $K_p = 2.7$, the models produced almost identical values for average daily density, with a spread of only about 7 percent. Above 700 km, the GOST 22721-77 yielded substantially lower density values than the other models. If the solar and geomagnetic activity levels either dropped or rose, the spread grew with altitude. Plots of the annual variation of average daily densities showed relatively close agreement in terms of curve forms and location of extremes at altitudes of 250 km and 400 km. The annual variation curves showed their greatest divergence at 1,000 km, with $F = F = 200$ and $K_p = 7$. An hourly plot for the day of the year with the lowest level of

solar and geomagnetic activity, the day with the highest, and a day representing the midpoint between the two showed the greatest divergence among the models to be at 1,000 km, on the day with the highest level of activity. Since atmospheric drag manifests itself primarily as a reduction in the semi-major axis of the orbit and as a shift in the satellite's orbit, the authors also calculated variations in the semi-major axis of a satellite's orbit for each model. For forecasting satellite motion for navigational referencing at altitudes less than 700 km the authors recommend use of the GOST 22721-77 model; for higher altitudes the DTM model is preferred. The MSIS-83 model is recommended for geodetic applications requiring more precise calculation of variations in atmospheric density. Figures 6; tables 2, references: 4 Russian, 10 Western. 13227/09599

UDC 528.225—629.783

Approximation of Atmospheric Density by Chebyshev Polynomials in Predicting Motion of Low Artificial Earth Satellites

18660004 Moscow IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: GEODEZIYA I
AEROFOTOSYEMKA in Russian No 3, May-Jun 87
(manuscript received 20 Oct 86) pp 70-75

[Article by V.A. Lupovka, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] A simpler analytical representation of a nonstationary model of atmospheric density was found for predicting the motion of low artificial earth satellites. A solution is obtained for the problem of approximation of a quite detailed and precise atmospheric model which in contrast to those described in the literature can exist autonomously of the initial model. The model is more compact and faster than previous models but takes into account all atmospheric density variations stipulated in the base model. Ballistic computations are based on GOST [State Standard] 22721-77. The model is represented in tabular-analytical form for taking into account the influence of the mean level of solar activity on atmospheric density variations. The $gdgr$ variations can be described using orthogonal polynomials in the form of multivariate interpolation forms, but this results in an unjustifiably large number of coefficients, most of them close to zero. A more compact solution is proposed with elimination of rapidly changing terms and insofar as possible precluding the reciprocal influence of effects. A hierarchical principle for describing variations is used for taking into account the influence of solar activity on other effects. Density variations associated with geomagnetic activity are represented in the most compact form using a solar-geomagnetic coordinate system; the best results are obtained in a system related to the eccentric geomagnetic dipole of the epoch in which the initial data for constructing the model were obtained. The auxiliary model is constructed using the MSIS-83 atmospheric model as a reference model. Chebyshev

polynomials are the most convenient for these purposes (an effective and simple recurrent algorithm already is available for their computation). Chebyshev polynomials are convenient for describing the form of the variations and for constructing a vertical profile and the unified approach improves the program. A model of the system of winds in the upper atmosphere, required in solving the problem, is also recommended. References 13: 8 Russian, 5 Western. 5303/08309

UDC 524.35

'Astron' Observations of Supernova 1987A in Large Magellanic Cloud

18660021a Moscow PISMA V ASTRONOMICHSKIY ZHURNAL in Russian Vol 13, No 9, Sep 87
(manuscript received 19 May 87) pp 739-743

[Article by A.A. Boyarchuk, R.Ye. Gershberg, A.M. Zvereva, P.P. Petrov, A.B. Severnyy [deceased], A.V. Terebizh, C.T. Hua and A.I. Sheykhet, Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy; Space Astronomy Laboratory, Marseilles, France]

[Abstract] The supernova 1987A flared in the Large Magellanic Cloud on 23 February 1987 and rapidly attained a brightness of about 4^m . It was decided to observe it from the "Astron" astrophysical station, but since none of the 15 standard reference stars could be used, Saturn was chosen as a reference object. Four series of observations were made: 4, 6, 9 and 12 March. Observations ended when Saturn was no longer suitable for "Astron" orientation. During the observations there was an appreciable general attenuation of supernova brightness. On 12 March the radius of the photosphere was 24 a.u., exceeding the orbital radius of Uranus, and the mean rate of increase in photosphere radius from the time of the flare was close to 2400 km/s. Three strong absorptions (glg12960, 3150 and 3260A) show up clearly on the registered spectra, but the strong blending caused by the great rate of expansion did not make it possible to draw any conclusions concerning the chemical composition of the emitting envelope. The supernova 1987A flared at the location of a hot star of the spectral class B3I, but no proof was obtained that a B3 supergiant had exploded. Special efforts were made to find traces of such a hot object on the registered spectra, but no evident traces of the spectrum of a hot star were discovered. Figures 2. 5303/08309

UDC 521.352

Gamma Radiation Expected From Supernova 1987A in Large Magellanic Cloud

18660021b Moscow PISMA V ASTRONOMICHSKIY ZHURNAL in Russian Vol 13, No 9, Sep 87
(manuscript received 15 May 87) pp 744-750

[Article by O.S. Bartunov, S.I. Blinnikov, L.V. Levakhina and D.K. Nadezhin, State Astronomical Institute imeni P.K. Shternberg, Moscow; Theoretical and Experimental Physics Institute, Moscow; Moscow Physical Engineering Institute]

[Abstract] The supernova 1987A flare began to attenuate only toward the end of May, about 90 days after onset of the event. This supernova is now [at the time of writing of the article] entering a phase when X- and gamma radiation can be expected at a level detectable by modern instruments. Observations in the hard electromagnetic range promise to give highly valuable information on the parameters of this object and the explosion mechanism itself. Several possible energy pumping mechanisms were considered and appropriate computations were made. All computations were made in the range 0.1-3.5 MeV. The main mechanism of energy loss of gamma photons is the Compton effect; the photoionization of heavy atoms and the photoproduction of electron-positron pairs were also taken into account in the computations. Computations were made by the Monte Carlo method. The parameters of the nucleus and envelope were selected in such a way as to best approximate a hydrodynamic model which describes well the initial phase of the SN 1987A flare. The density distribution is divided into two regions. The flux maximum is the variant with the 3.24 MeV line is predicted for t_m approximately 330 days; the gamma radiation fluxes are quantitatively estimated. [The authors expect that a large volume of observational data will be available by the time of publication of this article which can be compared with these model predictions.] Figures 3; references 16: 9 Russian, 7 Western. 5303/08309

UDC 629.015

Orbital Evolution of Distant Artificial Earth Satellites

18660114a Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun 87 (manuscript received 9 Jun 86) pp 339-355

[Article by M.A. Vashkovyak]

[Abstract] A study was made of the main features of orbital evolution of artificial earth satellites (AES) with semimajor axes 100-200 thousand kilometers in time intervals of about 5-10 years using a numerical analysis method. The greatest difficulty is caused by the rather strong lunar perturbing influence. In the analysis this makes it necessary to use a model of an evolving lunar orbit and in the expansion of the perturbing function to take into account a considerably greater number of terms than in the case of a geostationary AES. Orbits with periods commensurable with a sidereal month are not considered. Slower variables (mean solar longitude, ecliptic longitudes of perigee and ascending node of the lunar orbit), changing with periods of 1, 9 and 18.5 years, are retained in the perturbing function. Other slow variables in AES orbits which are taken into account are eccentricity, argument of perigee and longitude of the ascending node. In the averaged problem the semimajor axes of AES orbits are constant values. The numerical analysis method used was described by the author in KOSMICH. ISSLED., Vol 24, No 3, p 323, 1986. A geocentric ecliptic coordinate system is used as the main

system and the averaged equations are written in canonical form for a second system of Poincare elements. The results are compared with the results of numerical integration of rigorous equations of AES motion with allowance for both lunar and solar perturbations. The ranges of changes of eccentricities and inclinations for initial almost circular AES orbits are determined for a 10-year period. Figures 12; references 7: 6 Russian, 1 Western. 5303/08309

UDC 531.36

Plane Periodic Satellite Motions Relative to Center of Mass in Neighborhood of Collinear Libration Point

18660114b Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 16 Jun 86) pp 356-361

[Article by N.I. Chirkina]

[Abstract] By applying the Lyapunov theorem on a holomorphic integral it can be demonstrated that there are two families of periodic motions of a point of infinitely small mass near the libration point L_2 . A study was made of one of these families of periodic motions for which the center of satellite mass moves in an orbit lying in the plane of motion of finite masses m_1 and m_2 , the distance between which is used as a unit of length. Such motion is possible with ordinary assumptions concerning the nondependence of the trajectory of the satellite center of mass on its motion relative to the center of mass. Three right-handed coordinate systems are introduced for solution of the problem. The extent of the periodic orbit of satellite center of mass near L_2 is considered small in comparison with the distance between the m_1 and m_2 points, characterized by the small parameter gy . This orbit can be stipulated by series in powers of gy . The equations of satellite motion relative to its center of mass allow solutions corresponding to plane motions for which one of the main central axes of the ellipsoid of satellite inertia during the entire time of motion is perpendicular to the orbital plane. With this taken into account, a study is made of the problem of existence and stability of periodic motions produced by plane rotations and oscillations of an arbitrary amplitude. References: 7 Russian. 5303/08309

UDC 629.7.4.681.82

Families of Periodic Solutions in Problem of Solid Body Rotation at Triangular Libration Point in Restricted Three-Body Problem

18660114c Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 28 Nov 85) pp 362-369

[Article by S.N. Lelyavin]

[Abstract] The model problem of studying satellite rotation at libration points is important due to development of numerous projects for using libration points of the

earth-moon system. By modeling a satellite in the first stage as a solid body it is possible to study rotation of a solid body M about the libration points. Triangular libration points are of the greatest interest because the motion of the center of mass of the solid body M at these points is stable. The theory of periodic Poincare solutions was used earlier by Yu.V. Barkin, et al. (KOSMICH. ISSLED., Vol 18, No 2, pp 191-206, 1980; Vol 22, No 5, pp 663-674, 1984) for studying families of periodic solutions for a solid body M situated at the triangular libration point of the restricted (circular or elliptical) three-body problem. This article represents a continuation of the mentioned studies and is devoted to periodic regimes of rotational motion of a solid body near the triangular libration point of the restricted three-body problem. A study is made of new families of periodic solutions. The basis for the research is the theory of periodic Poincare solutions for Hamiltonian systems of the standard type and the equations of rotational motion in normalized canonical variables. Figures 4; references: 6 Russian. 5303/08309

UDC 629.78.015

Rotational Evolution of Dynamically Symmetric Gyrostat With Internal Friction

18660144d Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 7 Aug 85) pp 370-373

[Article by M.L. Pivovarov]

[Abstract] The presence of a passive damper of nutational oscillations on satellite ensuring evolution of rotation into permanent rotation makes it possible not only to preclude stabilization errors, but also to employ the simplest and most economical algorithm for the control of motion. Only an impulse is required, for example, in order to correct the direction of the kinetic moment of the satellite, after which the damper eliminates oscillations of the angle of nutation which arise without changing the position of the kinetic moment in absolute space. A free flywheel dispersing energy due to viscous friction in the bearings is one of the simplest types of dampers of nutational oscillations. The averaging method is used in this study of rotational evolution of a dynamically symmetric satellite with a damping flywheel on the assumption that the perturbing moment caused by influence of the damper is small in comparison with the kinetic energy of satellite rotation. A dynamically symmetric gyrostat was investigated; the axis of the free flywheel is orthogonal to the gd -axis and the directions of the gy - and gh -axes are such that the flywheel axis is parallel to the gh -axis. There is viscous friction between the flywheel and gyrostat body. In this formulation it is shown that the solid body rotation problem is integrable. An analytical dependence between the angle of nutation and time was found and the optimal viscosity ensuring the most rapid decrease in the angle of nutation was determined. Figure 1; references 9: 8 Russian, 1 Western. 5303/08309

UDC 521.13

Resonance Effects Accompanying Motion With Low Thrust in Earth-Moon System

18660114e Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 4 Dec 85) pp 374-383

[Article by A.Yu. Kogan and V.A. Kotin]

[Abstract] Many studies have been made of spacecraft motion along spiral trajectories in the earth's sphere of attraction, but insofar as is known, none take the perturbing effect of the moon into account, although it has never been demonstrated that neglecting of this effect is admissible, especially in resonance cases. Accordingly, a study was made of interorbital resonances and their effect on the spiral trajectory of a spacecraft. The study is limited to plane motions of a spacecraft and the lunar orbit is assumed to be circular. The investigation is made within the framework of the restricted circular three-body problem, complicated by allowance for jet acceleration. The possibility of capture at resonance is examined. It is shown that sometimes when commensurability is attained between the periods of revolution of the spacecraft and moon the evolution of the spiral orbit ceases because the engine thrust is compensated by lunar attraction. Only one of the possible mechanisms of capture at resonance is studied: winding of a spiral trajectory into an asymptotically stable periodic orbit. The problem is examined in a uniformly rotating coordinate system in which the earth and moon are at rest. It is shown that under definite conditions the influence of orbital resonances qualitatively changes the character of motion, including even the occurrence of capture. An analytical expression for describing these conditions is derived. Examples of asymptotically stable resonance orbits are presented. Figures 5; references: 9 Russian. 5303/08309

UDC 629.782

Increasing Accuracy in Evaluating Vector of State Under Conditions of Incomplete Observability of Expanded System

18660114f Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 5 Sep 85) pp 384-392

[Article by M.P. Igonin and A.L. Katkov]

[Abstract] An increase in accuracy in determining the vector of state of an object of control can be achieved by increasing measurement accuracy or by improving data processing algorithms. Dynamic filtering is one of the most effective of these processing methods, in many cases considerably reducing the level of errors in evaluating the vector of state of the object of control caused by high-frequency components of external perturbations (noise) and errors of control system sensors, with the errors in evaluating the vector of state being determined

for the most part by the slowly changing (low-frequency) components of external perturbations and errors of measuring instruments. Compensation for the influence of these two factors on the accuracy in evaluating the vector of state is possible by expanding the control system vector of state. The low-frequency components of perturbations and sensor errors are represented in the form of output variables of a linear dynamic system. The combining of the latter with the initial system forms an expanded system and the dynamic filter is synthesized in such a way as to obtain evaluations of the vector of state of the expanded system. If the expanded system is completely observable, its vector of state can be precisely determined; otherwise not all the components of the vector of state can be determined. In order to overcome this problem an algorithm for processing measurements is proposed which, with definite restrictions on the parameters of a not completely observable expanded system, ensures a minimum of the stipulated function characterizing the steady errors in evaluating the components of the object of control (initial system) vector of state. The results are illustrated in an example and can be used in the synthesis of systems for the control of spacecraft motion. References 8: 7 Russian, 1 Western. 5303/08309

UDC 629.785

Canonical Variables and Canonical Integrals for Motion in Near-Circular Orbits

18660114g Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 22 May 86) pp 393-399

[Article by A.B. Nayshul]

[Abstract] Although the relations for the derivatives of coordinates of Keplerian motion are quite well known with respect to their initial values, it can be demonstrated that for near-circular motion it is possible to select a special system of variables in which these derivatives are stratified in three subspaces and acquire a graphic form. Since these properties are related to the reduction of linear operators to canonical form, the new variables and their derivatives are called "canonical." A study was made of the isochronal partial derivatives of the current characteristics with respect to initial conditions of motion in a rectangular coordinate system. The unit of length used is the radius of a reference circular orbit and the unit of time is the time of rotation of the satellite radius vector in this orbit per radian. In this system of units in a circular orbit the velocity v , gravitational acceleration g , gravitational parameter gm and angular velocity of motion in orbit gq are equal to unity. In an example it is shown that by using canonical integrals in some cases it is possible to obtain simple analytical formulas for solving navigational problems. Although problems of optimal correction in near-circular orbits are usually solved by numerical methods, it can be shown that under certain conditions, imposed on the possible values of the canonical integrals at the ends of

the maneuvering interval, the optimal parameters of the correcting impulses can be found using simple analytical formulas. Figures 3; references: 2 Russian. 5303/08309

UDC 550.388.2

Model Representation of Electron Concentration Distribution in Outer Middle-Latitude Ionosphere Using Data From 'Intercosmos-19' Artificial Earth Satellite

18660114h Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 8 Jan 86) pp 410-420

[Article by N.P. Benkova, A.D. Legenka, N.A. Kochenova, M.N. Fatkullin and M.D. Fligel]

[Abstract] The outer ionosphere was empirically modeled for daytime summer conditions in the middle latitudes on the basis of data from satellite and surface soundings. This represents a refinement of work already published (N.P. Benkova, et. al., "Model Representation of Mid-Latitudinal Electron Density by Means of 'Intercosmos-19' Data," SPACE RES., Vol 4, p 51, 1984). In that study the zone examined was 40-50SD, with a 120SD breakdown longitudinally (350-50SD and 170-230SD; 230-350SD; 50-170SD). However, the longitudinal differences in the third zone were too great for all the data in this zone to be combined in a single model. Moreover, it was found that the first zone had to be divided into two sectors (Europe and Pacific Ocean). Accordingly, the original model has now been modified by the discrimination of five sectors. Much more material has been exploited in comparison with the original scheme, but as before, use was made of ionospheric data only for slightly disturbed magnetic conditions, as is customary in ionospheric modeling. The full description of the revised model given here includes a brief description of the data used and the dependence of the parameters of the F region maximum (electron concentration N_m and altitude h_m) on solar activity (Section 1); dependence of electron concentration N at fixed altitudes on solar activity (Section 2); normalized electron concentration profiles, analytical representation of models and comparison with other models (Section 3). The range of solar activities examined was $F_{10.7} = 60-300$. The model is represented by the exponential formula $N/N_m = \exp[-gb(h - h_m)]$, where the parameters of the maximum N_m , h_m are linearly dependent on solar activity. Figures 5; references 9: 5 Russian, 4 Western. 5303/08309

UDC 550.383

Ring Current Role in Dynamics of Fluctuating Electron and Ion Fluxes in Low-Latitude Magnetosphere

18660114i Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 18 Feb 86) pp 421-425

[Article by N.M. Shyutte and N.I. Izhovkina]

[Abstract] Data from the "Cosmos-900" satellite revealed the presence of electron and ion fluxes with

fluctuating energy spectra in the low-latitude magnetosphere, suggesting an instability of particle fluxes relative to wave generation in the VLF and ELF frequency ranges. These fluxes have the following local structure: the maximum intensities of electron fluxes under quiet and moderately disturbed conditions are approximately two orders of magnitude greater than for ions; the energy spectra for ions are less smooth; the total densities for the electron and ion plasma components (for $E = 100$ eV-20 keV) are virtually identical (quasineutrality of plasma is not impaired). There is a dependence of the frequency of appearance of such fluxes for low L-shells on the D_{st} index, to a considerable degree characterizing the dynamics of ring current dynamics. With an increase in the absolute D_{st} value the frequency of appearance of fluxes with fluctuating energy spectra at low L-shells decreases. Such fluxes are observed most frequently in the zone of the South Atlantic magnetic anomaly. This is evidence of a dependence of these fluxes on geomagnetic field structure. The diffusion of such fluxes in the middle-latitude magnetosphere is evidently controlled by processes accompanying ring current development, possibly by processes of radial and pitch angle diffusion of particles in the region of capture of VLF and ELF waves in waveguide channels at the plasmasphere boundary. Figures 2; references 11: 5 Russian, 6 Western. 5303/08309

UDC 551.521.8

Plasma of Earth's Magnetosphere Ring Currents. Model Compared With Results of AMPTE/CCE Experiment

18660144j Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 29 Jan 86) pp 426-438

[Article by V.V. Temnyy]

[Abstract] A model of the distribution of ion energy density in the ring current region was developed on the basis of experimental data for 1961-1983 in order to demonstrate the stationary filling of this region with plasma having an energy density commensurable with geomagnetic field energy density. Four main features of the quiet ring current were defined on the basis of a comparison of a model of the radial variation of energy density in the quiet ring current in the earth's magnetosphere and the parameters of the energetic ion component of plasma found in the AMPTE/CCE experiment. It was found that the radial variation of modeled ring current energy density, close to the geomagnetic field energy density at L greater than or equal to 4, coincides with the registered radial variation of plasma pressure perpendicular to the magnetic field, varying little during a magnetic storm. A hot component of ring current ions with temperatures of tens of keV, a concentration of more than 1 cm^{-3} and an energy density of about $100 \text{ keV} \cdot \text{cm}^{-3}$ was discriminated when the ion distribution functions obtained using spectra from the AMPTE/CCE experiment were approximated by a Maxwell approximation.

The concentration and energy density of oxygen ions indicate an ionospheric source of ring current hot ions. The transport of ions into the ring current from the ionosphere may occur due to ambipolar diffusion. The drift of ring current ions with the observed pressure gradient results in formation of a drift ring current with a westerly direction. The direction of the magnetic moment at the center of the quiet ring current coincides with the direction of the geomagnetic dipole. Figures 4; references 33: 4 Russian, 29 Western. 5303/08309

UDC 551.510.535.2

Experimental Proof of Quasilonitudinal Propagation of Low-Frequency Waves in Middle Latitudes in Upper Ionosphere

186601141 Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun 87 (manuscript received 20 Mar 86) pp 464-465

[Article by V.I. Altyntseva, V.F. Gubskiy and V.I. Larkina]

[Abstract] Many satellite experiments have been carried out for measuring low-frequency radiations and plasma density, but only a few for simultaneous study of these phenomena. Such a simultaneous investigation was made from the "Intercosmos-19," continuing research by the "Intercosmos-10" and "-14." Low-frequency radiations, thermal plasma parameters and energetic particle fluxes were registered simultaneously in various energy ranges. The wave experiment instruments measured the mutually perpendicular electrical and magnetic components of the field of low-frequency radiations at 140, 450, 800, 4650 and 15000 Hz. Improved instrumentation was used. Simultaneous measurements were made along the nighttime orbital segment from the equatorial to the auroral latitudes. Computations revealed that in the middle latitudes 50SD or lower at all frequencies in the ELF range the waves are propagated quasilonitudinally. The low-frequency waves generated in the equatorial region at plasmasphere altitudes are propagated, for all practical purposes, along the magnetic field lines of force. Therefore, in the middle latitudes measurements of the magnetic and electrical components of the field of low-frequency radiations can be used for determining plasma concentration if no measurements of the latter are available. The agreement (plus or minus 15

of computed and measured density of plasma particles at satellite altitudes thus makes it possible to use satellite wave experiments for determining plasma parameters. Figure 1; references: 3 Russian. 5303/08309

UDC 551.510.535.2

One Equatorial Anomaly in Nighttime Ionospheric F Region

18660114m Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun 87 (manuscript received 9 Apr 86) pp 466-467

[Article by G.V. Givishvili, N.A. Kochenova, L.N. Leshchenko and M.D. Fligel]

[Abstract] Mass-spectrometric measurements made in the winter of 1971-1972 using the "Cosmos-469" satellite indicated that at the base of the nighttime F region there are local zones with anomalously low concentrations of charged components. These zones are associated with certain sectors of the earth's surface and are observed for a number of years. New observational data were obtained during 1978-1980 on the "Akademik Korolev" and with the "Intercosmos-19" satellite and these have been used in checking this conclusion. The largest-scale anomaly in the nighttime F region is in the equatorial latitudes in the longitude range 160-210SD and, therefore, vertical soundings obtained in this longitude-latitude region were used. In the range 165-205SD in the entire altitude range below the layer maximum there was a stable N decrease attaining an order of magnitude or more in comparison with the background N concentrations at 160SD and 210SD. This peculiarity in spatial N distribution is observed not only at the layer base, but also near its maximum, where N_m decreased by a factor of 2-4. The drop in N_m values is accompanied by an increase in altitude of the maximum of the $h_m F_2$ layer. During the winter solstice at least one local large-scale zone with anomalously low electron concentrations is regularly observed in the nighttime equatorial F region. At altitudes of the base the N decrease is 1-2 orders of magnitude, whereas near the layer maximum N decreases by a factor of 2-4. The decrease affects the region from the base to the F2 layer maximum (and possibly higher). Figures 2; references 2: 1 Russian, 1 Western.

UDC 550.383

Influence of Plasma Parameters on VLF Radiation in Near-Rocket Region

18660114n Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun 87 (manuscript received 18 Feb 86) pp 467-470

[Article by N.I. Izhovkina, S.A. Pulinets and Ye.P. Trushkina]

[Abstract] In the "Araks" experiment, during injection of electron pulses from the rocket into the ionosphere, radiation in the VLF range with a clearly expressed spectral maximum was observed. The radiation was registered in the frequency band 0.1-5 MHz by a wide-band receiver aboard the nosecone separated from the rocket. The nosecone was at a distance of about 8 km from the injector in the direction along the geomagnetic line of force passing through the injector and about 1 km from the line of force upward from the rocket. As an additional means for neutralizing rocket charge the rocket carried a plasma generator operating only in the trajectory segment emitting cesium plasma with an effective current approximately 10 A. There was a great difference in the spectra of VLF waves when the plasma generator was operative and nonoperative. Some aspects of this problem were discussed earlier by the authors in KOSMICH. ISSLED., Vol 24, No 1, pp 139-143, 1986.

This article emphasizes analysis of the spectral characteristics of VLF radiation measured with the plasma generator operative. Data are given on the spectra registered during electron gun pulses, restructuring of the current system near the rocket and VLF-wave spectra computed for different variables. The observed changes in wave spectra during plasma generator operation can be attributed to the nonuniformity and nonstationary character of the external magnetic field near the rocket as a result of change in plasma conductivity in the neighborhood of the rocket and current system restructuring. Figures 3; references 2: 1 Russian, 1 Western. 5303/08309

UDC 543.42:522.124

Charge Composition of Primary Cosmic Ray Nuclei With z Greater Than or Equal to 2 in Energy Region Greater Than or Equal to 2 TeV

186601140 Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 17 Jun 86) pp 471-473

[Article by I.P. Ivanenko, N.L. Grigorov, V.Ya. Shestoporov, Yu.V. Basina, P.V. Vakulov, Yu.Ya. Vasilyev, R.M. Golynskaya, L.B. Grigoryeva, D.A. Zhuravlev, V.I. Zatsepin, A.Ye. Kazakova, V.D. Kozlov, I.P. Kumpan, Yu.A. Laputin, L.G. Mishchenko, V.M. Nikanorov, L.P. Papina, V.V. Platonov, D.M. Podorozhnyy, I.D. Rapoport, G.A. Samsonov, L.G. Smolenskiy, V.A. Sobinya-kov, V.K. Sokolov, G.Ye. Tambovtsev, Ch.A. Tretyakova, Yu.V. Trigubov, I.M. Fateyeva, L.A. Kheyin, L.O. Chikova, V.Ya. Shiryayeva, B.M. Yakovlev and I.V. Yashin]

[Abstract] An experiment for studying cosmic ray particles with an energy approximately 1 TeV or greater was carried out in 1984 using the "Sokol" instrument carried aboard the "Cosmos-1543." Particle energy was measured using an ionization calorimeter and particle charge was measured using Cerenkov detectors of two types (DZ-1 and DZ-2) situated above it. The instrument itself and the system for selective registry of events are described by S.N. Vernov, et al. in PROC. 17 ICRC, Vol 8, p 49, 1981 and PROC. 19 ICRC, Vol 2, p 52, 1985. Protons and alpha particles are reliably separated in the DZ-1 detectors. The fraction of alpha particles among the registered protons and the fraction of protons among alpha particles does not exceed a few percent. The charge distribution of nuclei with z greater than 5 for the energy interval 1-10 TeV and the charge distribution of nuclei with z greater or equal to 2 for an energy greater than or equal to 2 TeV are represented in Figures 1 and 2. The statistical material was increased for nuclei with close z values by combination into groups (alpha, M, H and VH). The number of nuclei in each group, after introduction of corrections, was normalized to the number of nuclei in group M. Data from other authors were also normalized to the M group. With transition to energies greater than or equal to 2 TeV the charge composition of

primary cosmic ray nuclei with z greater than or equal to 2 does not experience significant changes. Figures 2; references 8: 1 Russian, 7 Western. 5303/08309

UDC 524.35

Measurement of Galactic Radio Emission at Frequency 37 GHz From Aboard Spacecraft

18660120a Moscow PISMA V ASTRONOMICHESKIY
ZHURNAL in Russian Vol 13, No 6, Jun 87
(manuscript received 3 Sep 86) pp 469-473

[Article by I.A. Strukov and D.P. Skulachev, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] P.G. Mezger postulated that the distribution of thermal galactic radio emission is dominated by extended low-density HII regions (ELD regions), with the remaining HII regions accounting for only 16

. However, until now it has been impossible to measure the parameters of extended sources of thermal radio emission with sufficient accuracy. The only way to eliminate these difficulties is by exoatmospheric scanning at relatively high frequencies. Such measurements were made during 1983-1984 from the "Prognoz-9" satellite during the "Relikt" experiment. The celestial sphere was scanned during satellite rotation over the course of 8 months; some regions were observed twice at an interval of 6 months. Measurements were made in the band 400 MHz near the central frequency 37 GHz; the antenna directional diagram had a width of $5SD.5$ at half-power. Each celestial sphere point near the galactic plane was observed about 5000 times; total observation time for each point was about 1.5 hour. The total number of measurements was about 15 million, about 1/10 of these near the galactic plane. Whereas Mezger found the IR excess to be 2.7-4.1, the new measurements are higher by a factor of 1.5-2.5, which would require a modification of the parameters of the distribution model and masses of ionized gas published by Mezger (ASTRON. AND ASTROPHYS., Vol 70, p 565, 1978). (The excess radiation was discovered in galactic quadrants I and IV.) A precise knowledge of the radiation intensity of extended sources in the short-wave part of the radio range is vital for proper interpretation of data for research on the anisotropy of relict radiation. In order to determine the parameters of distributed sources more precisely it is necessary to carry out exoatmospheric scanning with an angular resolution 1-2SD at several frequencies simultaneously. Figures 3; references 14: 3 Russian, 11 Western. 5303/08309

UDC 524.38

Binary Star Measurements Using Digital Speckle Interferometer of 6-M Telescope

18660120b Moscow PISMA V ASTRONOMICHESKIY
ZHURNAL in Russian Vol 13, No 6, Jun 87
(manuscript received 30 Dec 86) pp 508-514

[Article by I.I. Balega and Yu.Yu. Balega, Special Astrophysical Observatory, USSR Academy of Sciences, Nizhniy Arkhyz settlement]

[Abstract] New results have been obtained from speckle-interferometer studies of binaries. The work has been done since 1983 using the 6-m telescope at the Special Astrophysical Observatory. The data collected earlier were published by Yu.Yu. Balega, et al. (PISMA V ASTRON. ZHURN., Vol 10, p 229, 1984; Vol 11, p 112, 1985; ASTRON. AND ASTROPHYS. SUPPL., SER., Vol 57, p 31, 1984). The observations described in this article are summarized in 3 tables. The work was done in November 1984 (4 nights) and March 1985 (3 nights). Table 1 gives 98 measurements of 80 binaries; 2 of these

stars, BD + 19SD662 and BD +23SD1346, were directly resolved for the first time. The table gives the catalogue designation, names, coordinates for epoch 2000, observation dates, position angles and distances. Table 2 gives information on observations of 20 binaries and suspected binaries which were unresolved with the 6-m telescope. Table 3 gives a comparison of position angle and distance measurements and computed values for 35 systems. Specific information is given on 12 of the objects listed in Tables 1 and 2. References 12: 3 Russian, 9 Western. 5303/08309

UDC 535.724:523.42

Microphysical Processes in Cloud Layers of Venus

18660115a Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 20 Feb 87) pp 448-455

[Article by D.V. Titov]

[Abstract] The principal microphysical properties of aerosol in the Venusian cloud layer were defined on the basis of available experimental data. The analyzed data reveal that the formation of new sulfuric acid particles as a result of homogeneous nucleation is possible only in the upper cloud layer at altitudes 60-65 km. The condensational growth of droplets occurs above 57 km where photochemical processes maintain a high sulfuric acid supersaturation level. Below this level supersaturation is too small for significant particle growth. Maximum droplet size is probably determined by the sedimentation-condensation-turbulent mixing balance. These processes are responsible for the prolonged lifetime of droplets measuring 2-3 micrometers. Sulfuric acid particles with a radius greater than 4 micrometers may remain in a cloud for a very short time. Coagulation controls the numerical density of aerosol. Aerosol with N_a greater than 10^4 cm^{-3} is unstable relative to this process, which explains why the aerosol density does not exceed approximately 10^3 cm^{-3} . Single-mode distributions in the submicron and micron size ranges are formed in the upper cloud layer. Mixing of particles growing under different conditions can result in the appearance of broad single- or bimodal size spectra similar to those which are experimentally observed. Figures 5; references 15: 5 Russian, 10 Western. 5303/08309

UDC 523.72:523.42

Stability of Venusian Ionopause

18660115b Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian Vol 25, No 3, May-Jun
87 (manuscript received 25 Mar 85) pp 456-463

[Article by A.M. Krymskiy]

[Abstract] The Pioneer-Venus spacecraft discovered in 1979 that although Venus does not have its own magnetic field, under conditions of low dynamic pressure of the solar wind, regions with a relatively strong magnetic field with a strength of 50-100 gamma could be detected. Characterized by field bursts of several seconds, and therefore having an extent of tens of kilometers, these regions were interpreted as plaits of magnetic lines of force. The nature of this phenomenon has remained unclear. One of the postulated mechanisms is ionopause destruction due to instability caused by a marked change in the velocity of plasma flow near the ionopause with transition from the moving plasma of the solar wind transition region to the at-rest plasma of the ionosphere and the transport of the magnetic plaits forming in the nonlinear stage of instability into the depths of the ionosphere due to plasma convection. Theoretical research has shown that Kelvin-Helmholtz instability develops in the region of small zenith angles. This hypothesis has been questioned. The analysis given in this article provides evidence that during periods of low solar wind dynamic pressure the Venusian ionopause is stable relative to perturbations with a characteristic dimension 50 km (the characteristic size of the magnetic plaits) in the region of zenith angles of 10 degrees or less. However, if solar wind dynamic pressure is great, this analysis of instability becomes inapplicable. During periods of great solar wind dynamic pressure the conditions for development of Kelvin-Helmholtz instability are less favorable. This research radically changes the conclusions drawn by R.S. Wolf, et al., JGR, Vol 85, p 7697, 1980, concerning ionopause stability. Figures 2; references 12: 6 Russian, 6 Western. 5303/08309

UDC 528.873.044.1

Determining Near-Water Wind Speed Using Radar Data From 'Cosmos-1500' Artificial Earth Satellite

18660121a Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 87 (manuscript received 11 Aug 86) pp 3-11

[Article by G.V. Volpyan and Yu.G. Spiridonov, State Scientific Research Center for Study of Natural Resources, Moscow]

[Abstract] The "Seasat" satellite carried a two-ray radar apparatus specially designed for determining speed and direction of the near-water wind in a scanning zone 2 x 475 km. However, it is questionable whether the instrument is optimal for solution of problems related to study of the near-water wind with respect to statistical reliability or spatial resolution. The side-looking radar on the "Cosmos-1500" with a scanning zone of approximately 470 km has considerably better spatial resolution (about 1 x 2 km) in comparison with the American scatterometer. This side-looking radar can be used in studying the detailed spatial structure of wind fields in rapidly changing synoptic situations, such as along fronts, in hurricanes and squalls and in some cases in obtaining estimates of wind direction for forecasting purposes. The statistical reliability of these estimates is ensured by the possibility of selecting the required "window" of spatial averaging of radar data for each situation. This article describes the method and algorithm used for determining the speed of the near-water wind using the physical calibration of side-looking radar relative to the known radar characteristics of multiyear sea ice. The theoretical basis of this method is a two-scale model of scattering of electromagnetic waves by the wave-covered sea surface, as proposed by F.G. Bass, et al. (IEEE TRANS. ANTENNAS AND PROPAG., Vol 16, No 5, pp 554-568, 1968). Two examples are given showing the high efficiency of the side-looking radar and the algorithm used in data processing: analysis of typhoon Ida and a high-latitude cyclone. Figures 2; references 12: 4 Russian, 8 Western. 5303/08309

UDC 551.465:629.78

Evolution of Thermal Structure of Benguela Upwelling System According to Satellite and Shipboard Data

18660121b Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 87 (manuscript received 22 May 86, after revision 20 Nov 86) pp 26-37

[Article by A.S. Kazmin, R. Legeckis and K.N. Fedorov, Oceanology Institute imeni P.P. Shirshov, USSR Academy of Sciences, Moscow; NOAA, Washington]

[Abstract] Hydrophysical research was carried out in the Benguela upwelling region along the Namibian coast (17SD-28SDS) in April-June 1985 during the 14th cruise

of the "Professor Shtokman." A joint analysis of shipboard and satellite data was made to determine the structure of ocean surface temperature (OST) and its evolution in the research area. The ship made six runs perpendicular to the coast with a minimum spacing of 15 miles. Infrared photographs from the NOAA-NESS satellite were also used. It was possible to trace the full cycle of development of the hydrological situation, which included: a greatly transformed state of the system under conditions of prolonged absence of upwelling of fresh waters, a relatively brief phase of active upwelling associated with wind intensification, followed by relaxation until a new upwelling event occurs. During the observation period active upwelling processes were of moderate intensity, upwelling of waters occurred from relatively shallow depths and the coastal upwellings on the front were much less sharp than on fronts to the south of 30SDS. A study was made of the horizontal and vertical structure of a stationary large-scale anticyclonic eddy on the boundary of the cold coastal waters and its influence on the OST field. During the observation period there were no cold transverse jets in the upwelling system, possibly attributable to the low intensity of the upwelling. Data were collected on the short-period variability of the state of the coastal upwelling front, manifested in strong meandering and eddy formation. Figures 7; references 15: 7 Russian, 8 Western. 5303/08309

UDC 551.521.16

Possibilities of Determining Vertical Profiles of Microphysical Characteristics of Stratospheric Aerosol Using Space Measurements of Transparency and Solar Halo

18660121c Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 87 (manuscript received 17 Apr 86, after revision 25 Jul 86) pp 54-63

[Article by P. Yu. Romanov, V.V. Rozanov and Yu.M. Timofeyev, Physics Faculty, Leningrad State University imeni A.A. Zhdanov]

[Abstract] Various space methods for measuring transparency of the atmosphere and the solar halo were evaluated applicable to determination of the microphysical characteristics of aerosol in three stratospheric layers (14-20 km, 20-30 km, 30-50 km). Parametric and histogram methods can be employed for numerical analysis of possibilities for retrieving the particle-size distribution function. It was found that a considerable quantity of information can be obtained concerning the microstructure of stratospheric aerosol in the particle-size range 0.1-10 micrometers contained in spectral measurements of transparency and solar halo brightness on slant paths. The spectral transparency or spectral halo methods may be more informative, depending on stratospheric altitude or the particular stratospheric aerosol model used. Simultaneous measurements are preferable in order to ensure maximum information yield. Definite information on the real part of the refractive index can

be obtained using the spectral halo method for a background model of stratospheric aerosol. Optical methods make it possible to refine a priori data on both the real and imaginary parts of the refractive index for a model of disturbed stratospheric aerosol (in this case the spectral halo method is more informative). A high accuracy in measuring solar radiation is needed for retrieving the microphysical characteristics of stratospheric aerosol. An increase in the error in measuring solar radiation from 1 to 5 SD results in a serious loss of information. Figures 2; references 20: 17 Russian, 3 Western. 5303/08309

UDC 528.7:551.5

Analytical Method for Approximate Geodetic Referencing of Scanner Images of Meteorological Artificial Earth Satellites Using Control Points

18660121d Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 87 (manuscript received 23 Apr 85, after revision 13 Mar 86) pp 109-115

[Article by M.V. Ivanchik and V.A. Krovotyntsev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] An approximate analytical method is proposed for the geographical referencing of satellite scanner images using control points. The method is intended for image processing on a computer when such relatively stable orbital parameters are known as orbital inclination to the equatorial plane and the period of satellite revolution around the earth. The method was used in studying the structure and dynamics of cloud cover in the Tropical Atlantic ICZ and in determining atmospheric dust formations along the coast of northwest Africa. The images received from meteorological satellite scanners are fed to a computer through a meter analog communication channel. In the computer the images are represented in the form of a matrix whose rows correspond to the lines of the scanner photograph. The position of the control points in matrix coordinates in the computer memory is determined from a photo marked off with dot-dash lines synchronized with matrix elements (described by M.V. Ivanchik, et al., ISSLED. ZEMLI IZ KOSMOSA, No 2, pp 111-116, 1985). Then photo distortions are corrected in the computer. The fully described referencing method, using one or more control point, does not require a knowledge of current satellite trajectory data but has an accuracy on the same order of magnitude as referencing by trajectory data. The formulas describing the method are simple and compact, making it easy to program problems with relatively little expenditure of computer time on photo processing. The method can be used on shipboard and stations for which trajectory data are unavailable. Figures 4; references 6: 5 Russian, 1 Western. 5303/08309

UDC 521.93

Determining Earth's Rotation From Laser Observations of 'Lageos' Artificial Earth Satellite (During Period of Main 'Merit' Campaign)

18660005 Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 3, May-Jun 87 (manuscript received 31 Jul 86) pp 75-82

[Article by I.M. Tsyupak, engineer, Lvov Polytechnic Institute]

[Abstract] An additional contribution is made to determination of the parameters of the earth's rotation by laser determinations of the LAGEOS artificial earth satellite as observed during the main campaign of the MERIT program. Ways to solve the many problems involved were outlined in the MERIT Standards. However, the traditional algorithm for determining the parameters of the earth's rotation do not take into account the erroneousess or neglecting of parameters of the earth's rotation arising in the numerical integration of the equations of motion of a satellite, although this influence may be significant when making highly precise observations. This article gives the results of series of determinations of parameters of the earth's rotation obtained during the period 1 September 1983-31 October 1984 using a new algorithm which takes this influence into account. A table gives the parameters of the earth's rotation for 89 arcs. Four solutions were obtained by the processing of 49, 506 normal points of laser observations distributed in a 14-month interval. An improved method is proposed for more precise determination of sidereal time on the basis of laser observations of artificial earth satellites. The stability of the solutions for polar coordinates obtained using the new algorithm is greater than that obtained by H. Montag, et al., published in 1985 in the proceedings of the MERIT symposium. References 8: 5 Russian, 3 Western. 5303/08309

UDC 528.77:550.814+629.78:551.25+553.042(235.216)

Oblique Metallogenic Zones Recognized by Interpreting Space Photographs of Southern Tien Shan

18660006a Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 25 Mar 86) pp 41-46

[Article by N.T. Kochneva, G.A. Tananayeva and R.A. Belov, Institute of the Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, USSR Academy of Sciences, Moscow]

[Abstract] Interpretation of space photographs has been widely used to locate metallogenic zones. This article discusses a new type of metallogenic zone which is oblique with respect to the folded structures. Oblique zones are zones of concealed basement fractures, oriented at 10-15° to the strike of the folded structures. The

Alayskaya oblique zone is described in detail. Such zones are found to control the position of various ore belts. They differ from penetrating ore-concentrating structures in metallogenic significance. The oblique lineaments of southern Tien Shan are associated with the boundary portions of rare-metal, rare-earth and antimony-mercury mineralization. Figures 3, references 5: Russian. 6508/08309

UDC 528.77:550.814+629.78(235.216)

Structure of Eastern Turkestan Ridge Based on Space Photographs

OVANIYE IZ KOSMOSA, Jul-Aug 87]

18660006b Moscow ISSLEDOVANIYE IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 18 Jun 86; after revision 22 Oct 86) pp 47-52

[Article by I.G. Tsukornik, A.V. Alekseyenko, A.V. Berezhanskiy and I.I. Soloshenko, Southern Kirgiz Geological Expedition, Osh; Lvov State University]

[Abstract] Analysis of data generated by interpreting space photographs made since 1976 in the eastern portion of Turkestan ridge reveals two morphologic structural types - linear and concentric. The linear structures are subdivided into the Tien Shan (sublatitudinal) and anti-Tien Shan (transverse) structures, the concentric structures are subdivided into circular and ellipsoidal. Four systems are most clearly recognized - two orthogonal and two diagonal systems of lineaments. The distribution of variously oriented lineaments over the area indicates the presence of three sublatitudinal and three submeridional zones. The latitude-oriented zones match the zonality of the Hereynian structural formation complexes. The transverse zonality reflects heterogeneity of the geological structure of the region and may be important in the distribution of useful minerals. Figures 4, references 11: Russian. 6508/08309

UDC 528.873.044.1

Determining the Spatial Structure of Fields of Precipitation From Space Radar Images in Two Orthogonal Polarizations

18660006c Moscow ISSLEDOVANIYE IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 4 Jul 86) pp 70-77

[Article by A.P. Pichugin, Yu.G. Spiridonov and A.B. Fetisov, Institute of Radio Physics and Electronics, Ukrainian Academy of Sciences, Kharkov; State Scientific Research Center for the Study of Natural Resources, Moscow]

[Abstract] Based on analysis of radar images produced with a side-looking radar installed on the Cosmos-1500 spacecraft, a study is made the effective scattering area of precipitation as a function of the characteristics of precipitation fields in the three-centimeter band. Use of

a dual-polarization method allows study of the three-dimensional structure of precipitation fields over broad areas over the ocean, determining the spatial distribution of precipitation intensity and more precise measurement of the specific effective scattering area of the ocean surface when precipitation is present. This is important in determining the natural wind velocity field and other hydrophysical parameters. Figures 6, references 20: 14 Russian, 6 Western. 6508/08309

UDC 528.813+631.1

Estimation of Soil Temperature Profile From Remote Microwave and IR Measurements

18660006d Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 6 Jan 86; after revision 11 Sep 86) pp 78-85

[Article by Ye. A. Reutov and A.M. Shutko, Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow]

[Abstract] A study is made of a method of estimating the soil temperature profile based on remote microwave and IR radiometric measurements. This article presents a broader interpretation of earlier results and does not assume constant moisture content with depth. All heat transfer processes in the soil are reduced to conduction, convection, radiation and moisture transfer. The method is suitable for estimation of soil temperature down to 100 cm depth with a maximum absolute error of not over 5.0-5.5°C and a mean square error of 3°C. Figures 5, references 9: Russian. 6508/08309

UDC 535.361+57.084.2:535.232.65

Monte-Carlo Estimation of the Influence of Plant Architecture Parameters on Spectral Brightness

18660006e Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 24 Sep 85; after revision 17 Jan 86) pp 86-93

[Article by Yu.K. Ross and A.L. Marshak, Institute of Astrophysics and Atmospheric Physics, Estonian Academy of Sciences, Tartu]

[Abstract] A previous work stated the problem of calculating the reflection of radiation from a soil-plant system, constructed and demonstrated an algorithm based on the Monte-Carlo method and described a plant cover model. This article turns primary attention to the study of the influence of the plant canopy architecture on the index of reflection. Factors analyzed include canopy height, distance between leaves, leaf size, canopy structure, leaf shape, genetic spiral angle of rotation and stems. The architecture is found to influence the index of reflection primarily in the area of reverse shine in the direction opposite to the direction of the incident sunlight and in the area around the nadir. Increasing the diameter of a circular leaf or decreasing the height of the canopy increases the spectral brightness coefficient. Increasing

ellipticity of leaf shape decreases brightness. Near the nadir, index of reflection depends on the contrast of spectral brightness between leaves and soil and the genetic spiral rotation angle. Increasing the fraction of vertical stems causes an increase in asymmetry of spectral brightness relative to the nadir direction. Figures 6, references 3: Russian. 6508/08309

UDC 528.72:629.78

A Stereocomparator Based on a Digital Display System

18660006f Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 14 Jan 86; after revision 5 Sep 86) pp 94-96

[Article by M.I. Kolesnik and D.A. Usikov, Institute of Space Studies, USSR Academy of Sciences, Moscow]

[Abstract] A digital stereocomparator based on a display system is described, not requiring the use of a binocular and allowing several persons to observe a stereo image simultaneously. The stereo image-processing software is suitable for both air and space generated images. Preprocessing can be used to enhance images. The use of digital display systems provides new capabilities for automation of the cartographic process. With relatively low cost, digital display systems can significantly accelerate the entire process and introduce a number of verification steps, which significantly improve the quality of comparison work. The digital models generated can be stored in libraries for subsequent development and refinement. Figure 1, references 3: 2 Russian, 1 Western. 6508/08309

UDC 681.3+528.72

Methods of Statistical Classification of Multiband Video Information Using Test-Sector Learning

18660006g Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 87 (manuscript received 28 Nov 85) pp 97-103

[Article by P.M. Guseynov, M.I. Kolesnik, T.V. Pyatibrat, Ye.I. Sysoyeva and D.A. Usikov, Institute of Space Studies, USSR Academy of Sciences, Moscow; Scientific-Production Association of Space Studies, Baku]

[Abstract] Two methods are described for classification of video information, each of which achieves the maximum possible speed in a class of computers. The effectiveness of the methods is demonstrated by processing a multiband image of an agricultural area. Each classification method involves three stages: An interpreter outlines a test section on the image; the statistical characteristics of the multiband image are calculated; all elements of the image are inspected. If the likelihood function of their membership in the class of the test section studied exceeds a given threshold, an element is shown on the display screen; smoothing of the classification points thus generated yields connected image areas. Full use of the statistical characteristics allows both

methods to distinguish sections with similar mean brightness vectors but different covariation matrices. The first method utilizes Mahalanobis distance computation, while the second utilizes multidimensional histograms for presentation of image statistics. Packages of application programs for implementation of the methods have been written in FORTRAN. Figures 5, references 8: Russian. 6508/08309

Experiment 'Telegeo-87' for Study of Geosystems
18660053 Moscow PRAVDA in Russian 9 Dec 87 p 6

[Article by L. Vasilyev, doctor of technical sciences, project director]

[Abstract] The article gives an account of an experiment called "Telegeo-87" which was carried out earlier this year. It is said to be one of a series of experiments which scientists taking part in the "Intercosmos" program have been organizing in line with an international project, "Study of Dynamics of Geosystems by Long-Distance Methods." Its program calls for studies of selected types of geosystems to be made on the territories of socialist-bloc countries, using aerospace technology. Geosystems are selected on the basis of their economic importance. Concerned organizations reportedly include institutes of the USSR Academy of Sciences and the USSR state agro-industrial committee and committee on hydrometeorology and monitoring of the natural environment. Research in line with the project is being conducted by an interdisciplinary group consisting of geographers, physicists, cartographers, agronomists, radiophysicists, soil scientists, mathematicians, cosmonauts, and specialists in image processing.

An experiment in this series called "Geoeks-86" was carried out last year in East Germany, it is recalled. This experiment included studies of geocological conditions of the city of Leipzig, using infrared photography. The author relates that the experiment "Telegeo-87" was conducted on territory of the USSR and the Polish People's Republic. The purpose of this experiment was to study dynamics of agricultural geosystems. Satellite-aided observations were made simultaneously on the ground and from the air, using a whole set of specially-developed optical, infrared and radiophysical instruments. Scanning equipment carried by the orbiting station "Mir" and earth satellites of the "Meteor-Priroda" and "Cosmos" series was employed.

The author goes on to relate that a method for determining the condition of agricultural geosystems on the basis of multizonal space photographs was developed for "Telegeo-87" at the USSR Academy of Sciences' Institute of Geography. Scientists of the academy's Institute of Radio Engineering and Electronics developed an airborne microwave moisture meter for observations which were conducted at a survey area in Poland early in the spring. This instrument makes it possible to determine the content and distribution of moisture in the soil up to a depth of approximately 1 meter, it is claimed.

Polish survey areas were photographed from a TU-134 laboratory airplane for the purpose of determining optical characteristics of vegetation and soil. In June, another experiment was conducted at the Rybinsk Reservoir with a view to evaluating effects produced by local agriculture and industry on the reservoir's condition. Satellite-aided measurements were made on land and water simultaneously.

FTD/SNAP /06091

KOSPAS-SARSAT Satellites Used for Ocean Current Study

*18660054 Moscow SOTSIALISTICHESKAYA
INDUSTRIYA in Russian 2 Dec 87 p 4*

[Article by Yu. Kolesnikov]

[Excerpt] KOSPAS-SARSAT satellites receive distress signals from special buoys which are carried by ground and air transport equipment. Scientists of the Ukrainian Academy of Sciences' Marine Hydrophysics Institute and the Lvov Polytechnical Institute thought: Why not

use these satellites for studying ocean currents? They developed methods and equipment for a suitable experiment, which was conducted in the tropical zone of the Atlantic Ocean near the coasts of Suriname, Guyana and Brazil.

The space rescue system ensured communication with the oceanologists' buoys for as many as five to seven times a day. Whenever one of the satellites passed over these drifting radio transmitters, it registered their position. The spacecraft recorded this information in its memory and transmitted it to earth while flying over receiving centers. The information was transmitted from the centers to the oceanologists' laboratories.

Another advantage of the new method is that long searches for buoys after storms and fogs will no longer be necessary. The equipment can be set adrift by practically any vessel whose route passes through a starting point designated by the scientists.

FTD/SNAP /06091

Interview With Chairman of State Commission for Flight Tests of Manned Space Complexes: Functions of State Commission

18660001a Moscow SOVETSKAYA ROSSIYA in Russian 22 Aug 87 p 2

[Interview with K.A. Kerimov, chairman of the State Commission for Flight Tests of Manned Space Complexes, conducted by V. Ovcharov and L. Chernenko. TASS special correspondents: "Recommended by Korolev"; the first paragraph is an introductory paragraph in the source]

[Text] Until very recently, television viewers did not know this man. Central Television operators and documentary filmmakers did not show him when he listened to the reports of the space crews before they were launched into orbit and upon their return to Earth. And for many years, we journalists have spoken of him in our reporting from the Baykonur cosmodrome and from the airport at Zvezdnyy Gorodok as the "anonymous" chairman of the state commission. Glasnost, however, as one of the principles of the restructuring, is gradually beginning to gain a foothold in spheres such as rocket and space technology that were once totally "closed."

Question: Now, when we finally have an opportunity to portray you, we would like to ask you first of all, Kerim Aliyevich, just what does your job consist of?

Answer: The State Commission for Flight Tests of Manned Space Complexes, which was created in 1965 for testing Soyuz spacecraft, has a broad range of duties. It examines and approves the engineering aspects of the flight programs for manned space complexes as well as the theoretical and applied research space programs for the Academy of Science and the economy. It analyzes the results of factory and bench tests of the equipment used on boosters, spacecraft, and on space stations, and it decides whether these complexes will be approved for flight-testing.

The State Commission approves the main crews and the back-up crews, directs the preparation and launch of space complexes at Baykonur, oversees control of the flight, the docking, the redocking, and the landing of spacecraft. In order to ensure routine space flights, it must know everything about the readiness of the cosmodrome, the command-and-measurement complex, the Flight Control Center, the main operational group controlling the flight, and the consolidated search-and-rescue complex.

It must make decisions on program changes and in unplanned situations, decisions involving even the curtailment of a flight and the landing of the crew in a given area of the country.

Question: And who makes up the government commission?

Answer: Its members consist of the main representatives of the many agencies and organizations that participate in the development of the individual components of the space complexes or that effect the preparation, launch, flight control, and landing of these complexes. Distinct from other state commissions that accept new structures or test new aircraft or rockets, our commission "guides" the space complex from the beginning of its development to its return to Earth.

Question: People get into cosmonautics in various ways. What was the route you took, Kerim Aliyevich?

Answer: I was born in Baku on November 14, 1917. My father was a production engineer, and he worked his whole life in the oil industry. My mother was a housewife. I received both my middle and higher education there in Baku. I graduated from middle school there, and then the Azerbaydzhan Industrial Institute, in 1941. I was accepted into the fifth course at the Artillery Academy imeni F.E. Dzerzhinskiy in early 1942. I graduated with a degree as a military artillery-engineer. My specialty was influenced by my activities in the radio club at the Baku Children's Technical Station [Bakinskaya detskaya tekhnicheskaya stantsiya], my studies at the institute in electrical engineering, and the military discipline I received at the academy. From 1943 to 1965, I was a staffmember of the USSR Ministry of Defense.

I was named chairman of the state commission for testing Soyuz spacecraft twenty-two years ago, on the recommendation of Sergey Pavlovich Korolev, with whom I had worked since 1946 during various stages of the development of our rocket and space technology. That year was when our friendship began. It was a close friendship, but not an idyllic one. There were disputes, and quarrels...At that time, Korolev was working on developing a ballistic missile, and I represented the interests of the customer.

Sergey Pavlovich was a very single-minded, extremely thoughtful individual. He used means that, at first glance perhaps, appeared unrealistic for achieving a goal. At the same time, he was very human and considerate of his subordinates. He was especially interested in unanticipated situations, and he himself participated in their analysis. And he would not let up until he found, say, the cause of a defect that had led to an unsuccessful launch.

As a rule, I should mention, failures occurred not as a result of some large miscalculations or errors in the work, but as a result of trifles, things that, at first glance, were the most inconspicuous. And it was quite vexing that they led to the destruction of structures such as rockets, which were very complex and had been developed through the efforts of a great number of people. And so, from the very beginning, we armed ourselves with the motto "There are no trifles in our work!" And that is our credo today.

Question: Could you recall two days from your life, Kerim Aliyevich—October 4, 1957 and April 12, 1961? Where were you on these days, and how do they appear in your memory?

Answer: When the world's first satellite was launched from Baykonur. I, unfortunately, was somewhere else—at the Kapustin Yar testing grounds, where, as chairman of a state commission, I was helping test a military rocket. But we knew, of course, of the satellite launch that was under preparation. And when the satellite went into orbit, we immediately began intercepting the broadcast of the radio call signals of this firstling.

On April 12, 1961, I was at Baykonur. I remember the early morning, the launch of the rocket, the first radio conversation with Yuriy Alekseyevich.

By the way, at that time the chairman of the state commission, my predecessor, was Konstantin Nikolayevich Rudnev. He was from Tula, an old weapons man [vooruzhenets], he was a very experienced specialist.

Question: And when you were chairman of the state commission, were there ever any "unanticipated" situations in which you had to make a decision that was later incorporated into cosmonautics?

Answer: There was, for example, one such instance in which a station that had been developed by a great number of people over two or three years was launched. And suddenly, on the very first orbit, on a segment in which our control points did not control the operation of the spacecraft, the attitude-control rockers began working irregularly. As a result, all the fuel reserves were burned up. What could we do with the station? After that, we came up with an idea: we would develop a space tanker that could dock with a station and refuel it. And soon afterwards we began developing the Progress cargo craft on the basis of the Soyuz ships. More than thirty of these craft have gone into action without a single failure.

Question: In rocket-and-space technology, precision, reliability, and discipline are regarded as a must today. Here, they say, God himself has instructed that you work that way...

Answer: But it was not always that way. When this industry was just getting under way, it leaned heavily on the production that we had then. And although the most advanced enterprises were chosen for setting up rocket production, the level of technology they had reached was still insufficient.

For that reason, we had to work strenuously on raising the quality of the parts and assemblies that were being manufactured. We had to set up a triple-check system, that is, one produced the component, another read the specifications, and a third checked to see whether what

was done matched the specifications. It was an extravagant luxury, but we had to devote ourselves to this more than anything else. We had to train individuals, find the "weak points" and eliminate them, and move ahead one step at a time.

State acceptance [Gospriyemka], which has now been introduced into industry, was an essential part of our work from the very beginning. Everything was subordinate to the necessity of obtaining high quality. Thus, it was decided to abolish such things as night work and piece-work pay. In our business, the most important thing is to work steadily and to accomplish a task on time. Nevertheless, the heat of competition was felt in our work—our competitors were the U.S. space firms. And, I must say that in such a complex realm as rocket and space technology, our country was in fact capable of catching and passing America. This testifies to the strength of the Soviet scientific and technical potential, and not only in terms of high professional qualities, but also in terms of the finest human qualities of our people, whose labors and searches were able to find a path to the most advanced frontiers.

Our rocket-and-space groups can serve as an example to everyone. When Mikhail Sergeyevich Gorbachev was at Baykonur, he said that, in solving the problems before us, we all need to work as they do at the cosmodrome: patriotically, letting our conscience guide our living and our work, and doing our assigned tasks competently.

Question: The Soviet-Syrian expedition aboard the Mir station was just successfully completed. The coming year will see flights with representatives from Bulgaria and France, and then Austria and Afghanistan. Talks are being conducted with other countries that would like to send people into orbit with the Soviet Union's help. Broad options are opening for the peaceful international development of space. Meanwhile, the U.S. government continues to increase its efforts to militarize space.

Answer: Although I myself am a military man, I can say one thing: there should be competition only along the paths to the peaceful development of space. Better yet—there should be cooperation. This was demonstrated well by the joint Soyuz-Apollo flight and the successful Venus-Halley's Comet project. We have many problems that must be solved jointly. Especially in the study of deep space.

I speak of deep space because I am still chairman of the State Commission for Flight Tests of Unmanned Interplanetary Spacecraft. Theoretically, today's technology makes it possible for mankind to retrieve soil from Mars with robotic spacecraft. We could have our joint forces carry out still other large-scale international projects.

The main thing is good will. And the understanding that the militarization of space is not only antihuman, but also senseless. It has long been known that any weapon

results in an antiweapon. And that is why there are no invulnerable systems of attack, even if today they are called defensive, as is the well-known SDI.

Question: This time we met with you, Kerim Aliyevich, not at the cosmodrome, but here in the Flight Control Center near Moscow. It is a normal day at the office. What is the day like?

Answer: My day begins early. I rise at six o'clock and do my exercises. At eight o'clock in the morning I am already at work. My working day never ends at the same time. Sometimes we spend our nights at the Flight Control Center.

Right here, at my fingertips is a telekeyer [telem manipulator]. I can use it to get telemetry data from orbit. I can find out everything that is happening on the Mir station, how Yuriy Romanenkio and Aleksandr Aleksandrovich are feeling, how their orbital home is doing, how the transport craft and the Kvant module are doing. By the way, the cosmonauts are totally occupied with astrophysical observations. They are feeling well and are in a working mood. Everything is going along routinely, according to program. They will work in orbit until the end of the year, and a new crew will replace them.

Question: And do you have any particularly earthly interests?

Answer: As it turns out, they are all tightly interwoven with what is going on in space. But I have been on good terms with the athletics my whole life, especially swimming. I look at the football reports, although rarely, and I cannot call myself a fan. I love literature. But I must say again that my thoughts are almost always with those who are working in orbit. 13227/12913

**Interview With Chairman of State Commission for Flight Tests of Manned Space Complexes:
Kerimov's Background, Current Duties**

*18660001b Baku BAKINSKIY RABOCHIY in Russian
19 Aug 87 p 3*

[Interview with Lt. Gen. K.A. Kerimov, chairman of the State Commission for Flight Tests of Manned Space Complexes, conducted by K. Isaakov: "Earth—Our Paternal Home"; first five paragraphs appear in boldface in source]

[Text] At noon on a sunny August day, an airport near Moscow greeted with flowers and smiles the Soviet-Syrian crew that had successfully performed a program of scientific studies and experiments aboard the orbital complex Soyuz TM-Mir-Kvant.

There are firm handshakes and embraces with relatives and close friends; flowers for the monument to the first space traveler, Yuri Gagarin; and the traditional exchange of opinions among the designers, the scientists, the flight directors, and the instructors from the Cosmonaut Training Center.

Heroes of the Soviet Union A. Viktorenko, A. Laveykin, and M. Farise report to State Commission chairman K. Kerimov.

These meetings were thrilling and unforgettable. Their joy—even though in Zvezdnyy they are used to accompanying their envoys to the next space watch and awaiting their victorious return—remains immutable.

After several days, this BAKINSKIY RABOCHIY correspondent met with Kerim Aliyevich Kerimov, Lenin Prize laureate, twice State Prize USSR laureate, bearer of the Order of Lenin, two Orders of the Red Banner of Labor, and the Order of the Red Star, and asked him to answer a number of questions.

Question: Describe, please, the recently completed Soviet-Syrian space flight.

Answer: It was marked by complete success, which, frankly, we Soviet space researchers had expected. In its turn, the Syrian side made a significant contribution to the flight, which, by the way, was our thirtieth international launch into the expanses of the Universe, and we are happy that the outcome met with our highest expectations.

Question: Are you working with Romanenko and Aleksandrov, who are now in space?

Answer: I, as well as other members of the commission, interact with these two cosmonauts through the operational program of the State Commission. Primarily, I worked with them (as, by the way, with other cosmonauts) during their preparation for the flight. But I will be working with them after their return—we usually hear reports and accounts of the results of the flight program's execution.

Question: All roads to the stars have their beginning on Earth. If you remember, the distant image of the paternal home arises from the cosmic depths clearly and plaintively before the hero of Lem's novel "Solaris". What memories have you preserved for yourself of your childhood, of your native home.

Answer: I am, you could say, the same age as the Revolution. I was born a week after the Aurora's legendary salvo on November 14, 1917. My father, Abbas Ali Kerimov, was a production engineer, and he spent his whole life working in the oil fields. He had three sons: I was the oldest, Suleyman was in the middle—he died at the very beginning of the war, and Mustafa was the youngest—he died in 1960.

I attended all my "universities" in my hometown of Baku. I finished Middle School No. 4 here. Then, the Azerbaydzhan Industrial Institute. That was in 1941, and my specialty was in electrical engineering. Back then, in my student days, I was already working in the Baku Radio Broadcasting Network—I ran the Mardakyan Radio Broadcasting Center. In early 1942, I was accepted into the fifth course of the Artillery Academy imeni F.E. Dzerzhinskiy. I received my degree as a military artillery-engineer in late 1943.

But if we are going to speak about where my "road to the stars" began, it most assuredly began at the Baku Children's Technical Station [Bakinskaya detskaya tekhnicheskaya stantsiya]. Those were interesting years. There was much that we did not know, but, it seemed, there were no mysteries of the Universe that we could not puzzle out.

I was named chairman of the State Commission for Testing Soyuz Spacecraft, on the personal recommendation of Sergey Pavlovich Korolev, with whom I had worked during various stages of the development of our rocket and space technology. So, if you are speaking of my space "godfather," it is that remarkable man!...

Question: Although mission control is the most earth-bound of all space operations, there have most certainly been some nonroutine situations, some extreme circumstances in your work.

Answer: These days, such situations have been covered well by the press, so there is no need to repeat them. I will only say that any testing like this is always training that serves to strengthen your character and later helps to tighten up our work even more. And as it is here on Earth, so it is beyond.

Question: Did you ever want to become a cosmonaut?

Answer: I have not had time to become a cosmonaut. In the late '50s, I was appointed chairman of several state commissions at the same time, commissions that were associated with studying the Universe. Later, I was named chairman of the commission for flight tests of the interplanetary stations that were being launched to Mars, Venus, and Halley's Comet.

Question: Recently in the press, an increasingly frequent topic of discussion has been anomalous phenomena in the atmosphere and in space. What do you think of it?

Answer: Anomalous phenomena of nature quite frequently interfere with our work, especially during the launch preparations of spacecraft. I think that here we should speak only about the optical effect created by the flight of various Earth-launched vehicles in the atmosphere.

Question: In terms of the future industrialization of space, when we will be placing equipment that is more advanced into orbit, what kinds of changes do you see taking place in terms of the function of the Mission Control Center?

Answer: That is an interesting question. I think that we will always need a person on Earth who takes responsibility for the fate of the cosmonauts—for securing the safety and the integrity of the program's execution. Automated data collection and analysis from aboard spacecraft already exists; the most advanced computers are used for those purposes. But nevertheless, it seems to me, there will always be a person at the control panel.

Question: What are your interests here on Earth? Are they connected with where you grew up? Has it been a long time since you have been in Baku?

Answer: My interests here on Earth have to do with the situation in space involving our permanently operating stations. As far as home, Azerbaydzhan, goes, unfortunately I have not been back since 1946. 13277/12913

State Commission Chairman Kerimov Interviewed on Occasion of Sputnik Anniversary

18660014 Moscow KOMSOMOLSKAYA PRAVDA in Russian 4 Oct 87 p 4

[Interview with State Commission Chairman Kerim Aliyevich Kerimov by S. Leskov: "Sputnik"; first paragraph in italics as published; second paragraph is an introduction]

[Text] *The term "sputnik" entered the vocabularies of the peoples of the world 30 years ago, when the first artificial earth satellite was launched in the USSR. But every spacecraft has had its own "sputnik" [companion]—a man, who has given the "go-ahead" for its launch. Today, the person we are speaking with is the chairman of the State Commission for Flight Tests of Rocket Space Complexes, Lt Gen K.A. Kerimov.*

Millions of television viewers have heard this man's voice. But few are they who have gotten to see the chairman of the state commission. Space crews report to him before launch and after returning from orbit, but cameramen modestly assigned him a spot out of the picture. Even his name was not well known, and in newspaper reports we simply called him "the chairman." But restructuring is making the spheres closed to publicity smaller and smaller, and it is touching on such specific topics as cosmonautics. So who is he then, this legendary chairman of the state commission?

Question: Kerim Aliyevich, allow me first of all to congratulate you on the 30th anniversary of the launch of the first artificial earth satellite, which took place on 4 October 1957. What are your feelings on the eve of this festive occasion?

Answer: Festive. As are, most certainly, all who are involved in the development of spacecraft, who know what work cosmonautics requires. For me personally, there is an added factor—I am going on vacation soon. I rest not during the beach season and not in September and October, but when there are no space launches.

Question: Exactly what does the work of the chairman of the state commission consist of? The solemn reports at Baykonur create the impression that it amounts to mere performance of a beautiful ritual...

Answer: You are seeing only the top story of the skyscraper. Actually, the ceremony is beautiful, as it should be on the threshold of an intricate space flight. But, besides that, the commission examines and approves the program of forthcoming scientific and applied research in orbit, scrupulously analyzes the findings of plant tests of all spacecraft and booster components, gives the go-ahead for launch, evaluates the readiness of the cosmonauts and approves the choice of main crew and back-up crew, and directs the preparations for the launch of a complex. Unlike that of many other state commissions involved in acceptance of new structures or testing equipment or aircraft, our work does not stop after the launch. The commission also manages docking operations, flight control, and landing operations. Any changes in the flight program are also subject to the approval of the state commission.

I will give you a specific example. Getting out of the unplanned situation when the Kvant astrophysical vessel was docking with the Mir station was done under the guidance of the commission. Every day at 10 in the evening we had a meeting. Or the recent unplanned crew replacement aboard the complex—that was also outside the confines of the program and required painstaking consideration.

Let me say a few words about the make-up of the state commission. It consists of representatives of the largest departments and organizations that take part in developing specific components of the complex and perform flight control operations. The state commission, which has existed in cosmonautics since the very first launches, is, in essence, a form of state acceptance [gospriyemka], which is also being introduced into other areas of the national economy.

Question: Our 30-year path to space has not been all roses. There have been thorns, too. It would be interesting to hear what you have to say: What are more reliable in space—people or equipment?

Answer: The logic of the development of cosmonautics, when more and more manual operations are being performed in automatic mode, can give the answer to that question. The machine, without a doubt, is more reliable. And what is more, it used to be that man had no faith in his equipment and intervened in the situation—and failed. That is what happened with one of the

Soyuzes. The cosmonaut decided to correct the ship's attitude and swung the vessel around—and then could not dock. But the equipment had provided the correct attitude. Experience tells us that in the majority of unanticipated situations, you can point to the human hand...

It is no accident that the most recent generation of the Mir station switched over to total computerization. Man, I think, must remain in space in the role of a repairman and an operator in situations that are not covered by the manual...

Question: Kerim Aliyevich, you belong to the generation in which space specialists were not yet being trained in the institutes. Does that mean that you got into cosmonautics by virtue of chance?

Answer: I am from Baku, and I was born with the October Revolution. My father worked his whole life as a production engineer. He died in the war. I got interested in technology when I was 7, when I first heard a radio broadcast on the street. I was literally astonished, and to this day, it is as if I remember a happy melody carrying from the loudspeaker on Kommunisticheskaya Street. I assembled a crystal receiver, and then a tube receiver. Some older friends and I built something of a television that could scan an image broadcast once a week from Shaboloyka. We were happy when we could make out the image of a man or a woman appearing on the screen. After school, I did not go on to competition for the Military Academy of Communications. I finished the Azerbaydzhan Industrial Institute, and in 1942 I was accepted into the Artillery Academy imeni F. Dzerzhinskiy. My interest in electronics and artillery led me to cosmonautics. It was all a logical progression.

After finishing the academy in 1946, I worked with S.P. Korolev in Germany, where we examined the V-2 missile research that the Germans had conducted...

Question: Recently, pages from Korolev's life that had never been mentioned were published. Along with a group of scientists from the Jet Research Institute [Reaktivnyy nauchno-issledovatel'skiy institut], he was accused of subverting our economy with work that had no prospects. But the V-2 itself represents a class of liquid-fuel rockets, the very same kinds of rockets that Korolev developed and that are flying to this day...

Answer: We asked the scientists who had worked for the Fascists how they got the idea of liquid fuel. They cynically answered: "We read Tsiolkovsky. Everything is explained there." Our own countryman developed the theory of rocket flight, but we almost let someone else have it. It is a painfully familiar picture in many of our industries. It was our good fortune to have Korolev in cosmonautics.

Question: Kerim Aliyevich, you worked with Sergey Pavlovich for more than 20 years. Most certainly, you were able to make many observations, and each new episode of Korolev's must have been priceless...

Answer: You could not call our relationship idyllic. Korolev was building a ballistic missile, and I represented the interests of a "purchaser." Korolev worked at an improbable speed, and from time to time it seemed to me that the design being developed would not be reliable enough. There were disputes, and there were arguments. What was their outcome? In 1965, I was named chairman of the State Commission on Manned Complexes, on Korolev's recommendation. More than anything else, Korolev valued a business quality in an individual. And he himself was a fine example of single-mindedness. Surprisingly, means that another leader would consider absolutely unrealistic, Korolev would use—and would get what he wanted. Sometimes, for the sake of a matter that was not going quite as he thought it should, he considered it necessary to arrange small dramatizations. During a meeting he would seat a consultant near the telephone and say, "I have to be able to call the most important person quickly." Or at the meeting itself he would exclaim, "Where is my large airplane? I am flying out to the site in an hour." You know, all this had an effect on people, brought them in. Korolev did whatever he had to do.

Question: Kerim Aliyevich, can you recall what you were doing on 4 October 1957, when the first artificial earth satellite was launched?

Answer: That day, as a state commission chairman I was involved with tests of a military rocket at the Kapustin Yar test site. But it would be impossible to describe the joy, no, ecstasy that overcame everyone when we heard those call signals from space. We immediately sent a congratulatory telegram to Baykonur.

A curious thing. Our newspapers made modest note of the launch. The foreign press, though, came out with 2-foot-high front-page headlines. Then, naturally, our journalists made up for the lost opportunity. My teacher, Academician A.A. Blagonravov, who was in the United States at that time, said that they literally carried Soviet scientists on their shoulders in New York. True, not right away. The first day after the launch, our American colleagues kept a death-like silence, and did not even congratulate us. Just think: 80 kilograms in orbit, right when they were planning to launch, in just a few months, what they themselves called an 8-kilogram "orange"!

Question: Thirty years after the beginning of the practical development of space, what are the problems in cosmonautics that seem to you the most critical?

Answer: Our boosters, our spacecraft, and our orbital complexes are extremely reliable. Thirty-two freighter craft have performed without a single failure (by the way, the idea of developing them originated in the state

commission). In all, the booster rocket developed by S.P. Korolev has been launched into space 1,300 times. Recently, the flight tests for the Energiya rocket, which is capable of carrying 100 tons, were successful. Rightly so, we are proud of our orbital stations, especially the last one—Mir—which is equipped with state-of-the-art gear.

But the practical benefits for the national economy from space research are still very few. Although there could be more. Unfortunately, some of the quite unique research involving materials science, biotechnology, medicinal preparations, and remote sensing of natural resources has yet to find practical application. A long-range, goal-oriented program of research to be conducted aboard orbital complexes has not been developed; requests come in from institutes sporadically. And by and large, we do not always know whether the things our scientists and cosmonauts are working on will have application in industry.

Question: There is talk of converting the field to economic accountability [khozraschet]. Is there evidence that if a system of orders is introduced, the management of experiments and the introduction of their findings will become more systematic?

Answer: I feel sure that the time has come in cosmonautics for fundamental economic reforms. Economic accountability would teach a lot of people how to count money. In any field, economics is the ultimate basis of everything, and if it is set up properly, there is no need for the monitoring aunts and uncles, the entire army of bureaucrats that only get in the way of the work. Economics itself finds the right path and sets a system right.

Question: Kerim Aliyevich, you have been chairman of the state commission for 22 years now. That is a very great...

Answer: Are you trying to ask, Why does no one want to take my place? Everyone knows—there are more bumps in the road here than there are smooth spots. You cannot even get sick. Many years ago, I was told, in complete seriousness, "Do what you have to do to not get sick." I am trying, and for me alone it is advantageous. I rise at 6 in the morning and do my exercises. In the summer I run, and in the winter I ski and I swim in the pool. That is, of course, if I do not have to spend the night in the Flight Control Center.

What else? Interests? I have no hobbies. To me, my work is the sort that makes any hobby seem flat, boring. And that is the kind of work I would wish to all the Komsomolka readers. 13227/06091

Career of Space Official and Chairman of State Commission G.A. Tyulin

*18660008 Moscow KRASNAYA ZVEZDA in Russian
19 Sep 87 pp 3, 4*

[Excerpts from article by Col. M. Rebrov: "Where the Cranes Fly"]

[Excerpts] For each, the war began in its own way. It caught each one at a different moment in his life and at a different stage of planning, but it pounced on all of them suddenly and mercilessly, cutting off the past from the present, the present from the future, with one swipe. On June 25, by order of the Krasnopresnenskiy party raykom, Georgiy Tyulin entered the ranks of the polit-boytsy [communists and komsomol members mobilized into active units of the Red Army]; and in November 1941, he was appointed commander of a detached battery of "katyushas" [rocket launchers].

The casual jacket fit snugly over the solid shoulders. His eyes were attentive and smiled a little in the corners. His movements were rapid and precise. Nevertheless, the precision was something I would see again—precision in movements large and small. Over the years, he had not lost the strength of that toughening that he received during the rigorous and unforgettable war years, and he remained ever an honest, strong soul, not always comfortable for everyone to be around. But more about that later...

I had occasion to meet with Tyulin before and had heard a lot about him. But our previous meetings had been infrequent and too short. Now, though, he said, "Today is something of a free day, and, I hope, we will not be disturbed." And somewhat quietly, he added: "There are only twenty-four hours in a day..."

While my host fussed with the coffee, I looked around the room. On the walls were photographs of designers, scientists, cosmonauts, with inscriptions and autographs... There was map of the far side of the moon, and in his cabinets, mockups of rockets and the lunar rover, and copies of pennants whose originals lie on the moon, Mars, and Venus. And books, on the shelves, on the table...

Tyulin—a professor, a doctor of technical sciences, and an RSFSR meritorious leader of science and technology—is past 70 years of age. He has had a life that has been extremely rich, filled to the brim with events of the most varying nature and scale.

It would be hard, even impossible, to imagine any other man, his hair greying with age, his face furrowed with wrinkles, as he was when he was a boy. But I can see clearly what Georgiy Aleksandrovich was like many years ago: passionate, restless, meticulous.

Komsomol committee secretary is an elected, public position, but it requires much. It requires personal study, it requires that you see to others' progress, it requires patriotic military work. The times demanded much, and the people of those times did much. All of the mechanical-engineering mathematics [mekhmat] graduates of MGU knew artillery. Tyulin and his comrades also

mastered navigation, flew on bombers, studied high-velocity aerodynamics, and wind-tunnel tested models that were brought to them by engineers from the "jet-propulsion" institute—the RNII [Jet-propulsion Scientific Research Institute].

A song of that era went "If there is a war tomorrow, if the campaign starts tomorrow, then be ready for the campaign today..."

War... Having traveled along its fiery roads through the Moscow area, Valday, Velikiye Luki, Nevel, Poland, Lt. Col. Tyulin entered Berlin in the victorious 45th. The Order of the Red Banner, the Order of Alexander Nevskiy, two Orders of the War of the Fatherland, two Orders of the Red Star, the Medal for Meritorious Combat, medals for "taking" and for "freeing"—all silently answered the question, How was the fighting?

In Berlin, Tyulin received an assignment: do a field study of the state of affairs at the rocket center in Peenemunde and at the underground plant Dora-Mittelbau, where the V-rockets were made. It was also suggested that he set up shop there and await specialists from Moscow. A sign that said TYULIN'S ENTERPRISE soon appeared at the outskirts of the razed city, and then a group of engineers arrived, among them Yu. A. Pobedonostsev, V. P. Glushko, N.A. Pilyugin, M.S. Ryazanskiy, and L.A. Voskresenskiy. In early September, S.P. Korolev arrived.

As soon as they met, Korolev said, "Why, we know each other." They recalled 1937, their university aerodynamic laboratory and the RNII orders. They then together "walked in the footprints" of Werner von Braun and "busied ourselves," as Georgiy Aleksandrovich puts it, "with paper and iron."

Once, Korolev asked, "When we finish here and leave, what are you going to do?"

"I am a military man," Tyulin answered. "Whatever my orders say."

"Let's build rockets together," Korolev insisted. "It is extremely interesting work."

There is a time for everything. But back then it was hard to guess that it would happen this way or that fate was preparing the rocket and space path for Georgiy Aleksandrovich Tyulin.

The famous Kapustin Yar, unfriendly, uninhabited, reminiscent of that song of the front—"dust and fog." Cold nights, frosts. And the sleeping quarters were tents or the cab of a truck. The people were, for the most part, from the front, and after having experienced a time of disaster, they had gotten into another. In severe freezes and in scorching heat, in yet to be completed buildings

and hangars, at testing grounds set up in the waterless steppe, they readied the "products" for launch. Some became crippled, some got frost-bite, but they continued to work "viciously."

"And how many times, after long, sleepless nights," Georgiy Aleksandrovich recalls, "as we swallowed the coarse sand and wiped away the dirty sweat, did we whisper through cracked lips, 'Let's go, sweetheart, fly, work like you are supposed to, don't go into the hill, as worn out as we have become for you, as much as we have invested in you. Why, you are our life...'"

Devoid of emotion, the official documents call all this "field testing" and "especially important work in terms of developing defense technology." But as a poet once said, inspiration is no less necessary in geometry than it is in poetry. And those who developed the first intercontinental ballistic missiles were not people who merely perform work, they were creators. They were not hangers-on; they did such delicate work that some called them surgeons of jewelers. And the roar of rocket engines ringing in their ears was to them, at full blast, a song caressing the ear with a melody.

Success should not be accidental. Test results are examined and verified, and verified and again examined. Success is the logical end of a design engineer's concept.

"Can you imagine the theory of rocket-building with a complete absence of numbers, signs, or formulas?" my conversational partner said, raising his eyebrows. "But the numbers are not at all the main thing. The main thing is the enthusiasm, the frame of mind, in which live and work people, who, commanded by their hearts and their minds, have taken upon themselves the most difficult of missions—to create a rocket shield for the homeland.

"They began working on the satellite in 1954," Tyulin continued, as he changed the subject. "And that was a new turn of history. Of history that was surprising, at the same time erasing, as it were, the boundary between fantasy and reality. In fact, why even use the phrase 'as it were'? Why, even on the eve of the events of October 3, 1957, could any of us have realized the significance of the birth of that new inhabitant of the Universe—the satellite—and how fantastic the events of the next day would be?"

He became quiet, as if by accident he had touched upon something forbidden. His big hands curled into a fist and lay heavily on the table.

"The significance of it was not simply that we had done it first," Georgiy Aleksandrovich said, clarifying what his earlier remarks. "Rather it was that at that time no one, except us, could launch, as well as build, large satellites for various purposes. The country was not striving for records, but to create a space industry and a scientific base."

Tyulin was soon appointed director of a scientific research institute that had been created in 1946. Everything was young there—the people, the laboratories, the administrative bodies. And to him, who was brimming with energy and vitality and the desire to get things done, it seemed that in the new research institute he would, above all, be able to show what he could do. Everything would simply come together. It turned out, however, that nothing came together by itself. Man must make it all happen himself. And that is not a very simple thing to do.

We need people, they told him—specialists of a certain kind. "Where are you going to find them, these specialists," he answered, "if they themselves do not grow here?" Reasonable? That is exactly it!

There were, of course, people. In numbers and for the positions. But they were, as it were, disassociated, disconnected, like stars that are disassociated by the chasm of interstellar space. And a train of new tests of courage and humanity began. I say "tests" because caution was expensive, and bravery suspect. Of course, without principles, and the struggle for them, you could not do great things.

"We forget from time to time," continues Georgiy Aleksandrovich, "that the socialist order is not something abstract or immaterial that works by itself. Socialism is living people, bearers of socialist views and attitudes. And there are some who must be trained, taught the correct attitudes in our society. The simplest thing is to point the finger at the guilty one when it comes to an incorrect action. But what about when it comes to unacceptable inaction?..."

Science is a complex, multilevel organism. The situation is such that it is not just geniuses who have a place in it. Norbert Wiener wrote, for example: "It is quite probable that 95 percent of all original scientific work belongs to less than 5 percent of the professional scientists; but most of it would never even reach paper, were it not for the remaining 95 percent who work with those scientists to create a rather high overall level of science." Thus, success depends on knowing how to guide the scientist's "production." From that, Tyulin began his own management.

There were conflicts—internal and with related industries. Sharp, painful conflicts. It would probably have been possible to keep them from coming to a head, except that Georgiy Aleksandrovich had no patience for "diplomatic missions."

In 1961, he was appointed deputy minister, and just like ripples in the water, the conversations began, the hubbub began: that one is admiring, that one is deferential, that one has a wait-and-see attitude; now, they say, he will put a stop to it.

In all honesty, Tyulin was not so happy with the new appointment. The research institute was on the rise, and the work was becoming more interesting. Mainly, though, it could see tangible results of its own labor. The uneven growth of the scale of responsibility was amplified by the fact that Tyulin also became chairman of the State Commission for Testing and Launching Rocket and Space Vehicles [Gosudarstvennaya komissiya po ispytaniyam i zapuskam raketno-kosmicheskoy tekhniki:]

Baykonur....Between the seasons, the steppe winds, arguing with each other, never quiet down. Their direction changes, but their nature does not. An inflexible constancy.

"The winds are like people," observed Georgiy Aleksandrovich. "On the cosmodrome, not only are rockets being tested, but also men are growing and coming of age, attaining the highest professionalism. I will tell you, experimental work is by far not for everyone. Intuition to its utmost must be combined with an uncanny ability to handle mentally complex situations and to analyze them with lightning speed. The people do not just search, they search until they find..."

In the first few seconds of their life, rockets sometimes fall and explode. At times, this happens much more often than it should. If you do not find the cause, you will not get any farther. The losses are immense. Not only in terms of money, but also in terms of "sweat" and lives. Bitterness, insult, fatigue—all of it is mixed together at that moment. Not seconds of tension, but months of it.

On the television and in the newspapers, spacecraft are launched right on schedule. Those involved with the work wear carefree smiles. Docking, landing, walking in space, multimonth excursions to the distant planets—all seem to happen by themselves. Everything is as if in a fairytale. In real life, though, it is different.

Tyulin "launched" Bykovskiy and Tereshkova, the Komarov-Feoktistov-Yegorov and Leonov-Belyayev crews, Luna-9, Luna-16, Luna-20, Mars, Venera. He conducted tests of the booster Proton, and he was "responsible for other equipment." And Tyulin often thought that it would be easier to be somewhere in a mudhut near Nevel than to be here, doing these tests.

To understand, to grasp, to help—this is the basis of his, a chairman's approach to the work. And he must also "straighten out any abnormal deviations from normal life." And it is not by accident that on one of the photographs given to him is this inscription: "To the chairman of the most difficult commission." It is signed, "Korolev."

How does one preserve oneself from the stress "tearing at the heart"? Upon returning from assignments, on which from time to time he was sent straight from his

office, only once did he let it slip to his wife that he had been tired during the testing, that his nerves had been frayed, that he could not sleep at nights.

"A stroke is a natural derivative," says Tyulin, using mathematical terms, and he leaves that topic. He does not say with false cheerfulness, "I was lucky, I got by!" Or "Sooner or later, all of us are there." He looks carefully at you: as if to say, why talk about this? And then quietly, and with confidence, he says, "The sentence was serious, but it was not subject to appeal. 'You get back into formation no matter what,' I decided while I was still in the hospital. And I returned..."

At Moscow State University he put to use the qualities he was born with and those he had acquired. There they remembered his lectures on theoretical mechanics; they remembered that Tyulin's lectures were so masterfully done that students came from other faculties to hear them. And now, he has new concerns: graduate students, special-seminar students, laboratories, the department of applied research, the integration of science and industry. Those are the things he is involved in today. Our meeting was postponed many times because of them. I understood the situation, but he always felt embarrassed about it.

Conversing with him was easy and difficult at the same time. He can, for hours, recall like a child things about his mother and father, and then quickly switch to subjects that are troubling the entire world, and then return to the war, to the launches of the R-1, the R-2, the R-5, to Gagarin's launch...The openness and ease, the freedom of the movements and the expressiveness of his face make his story somehow special. And I catch myself in thought, thinking all the time about this specialness. What is it? Tyulin speaks very warmly and respectfully of those with whom his fate has acquainted him. Marshals M.I. Nedelin, N.N. Voronov, and N.D. Yakovlev; generals A.I. Nesterenko and M.G. Grigoryev; academicians S.P. Korolev and M.V. Keldysh; designers, ministers, plants directors, shop heads...It would be hard to name everyone in the ranks of those who created the homeland's might.

"And do you know what all these people who are so unlike each other have in common?" he asks. He answers the question himself: "They have never been troubled with vanity. They do not have this most unpleasant trait, which forces a man, as they say, to lean over backwards for temporary success..."

Yes, everything on the earth is based on honest labor. It starts with it and ends with it. And the years here are not marked by arrogance. Georgiy Aleksandrovich Tyulin has mastered this truth categorically. And my seeing that provided the answer to the question, what is the most important thing about this man? His trustworthiness. And perhaps also, his persistence. No matter what kind of wind was blowing, it could not knock him off his axis.

"I received a mathematical education," says Georgiy Aleksandrovich, as if justifying himself. "I am accustomed to numerical assessments. Today, man learns more in a year than he once did in a millennium. That is a fact. Does it not mean that we forget with the same speed. We do not forget absolutely. Everything is preserved in the dead memory of books, reports, and computers. But we forget to use the experience of the past. And it applies to our needs today. And we should not slander everything of the past. There are always more honest people..."

After listening to Tyulins thoughts on time and himself, I become convinced that the past of, which veterans are so jealous, has something to be envied.

A reflection of the war lies in his story about years distant and near. The war powerfully controls his feelings and thoughts, for he took away much and ended the lives of those close in blood and spirit.

As I left him, I stared at a portrait. It was of a general in parade uniform, with combat ribbons—the Order of Lenin, the Order of the October Revolution, the Order of the Red Banner of Labor, the Gold Star of the Hero of Socialist labor, the Lenin Prize medal. I recalled the words from a poem that said that "the medals for combat and medals for labor are poured from the same metal." And I thought, "The formula that says that fate can take various turns, depending on how it was written at birth, does not apply to Tyulin." He chose his own fate himself. He is true to it. And the battle continues further. 13227/12913

Interview With Chief of Glavkosmos A.I. Dunayev
18660011 Moscow SOTSIALISTICHESKAYA
INDUSTRIYA in Russian 3 Oct 87 p 4

[Interview with Aleksandr Ivanovich Dunayev, chief of Glavkosmos, by G. Lomanov: "On the 70th Anniversary: Your Reliable Satellites"; first paragraph published in boldface]

[Text] Chief of Glavkosmos USSR A.I. Dunayev answers the questions of the newspaper SOTSIALISTICHESKAYA INDUSTRIYA.

G. Lomanov: Aleksandr Ivanovich, the first artificial earth satellite went into orbit 30 years ago, and the space era began. Everyone is aware of the tradition—on anniversaries, we put what we have achieved into perspective. In the field of cosmonautics, piloted flights draw more attention than anything else. That is understandable—every cosmonaut has his own destiny and his own character, unexpected situations come up during the expeditions, and the scientific program is quite varied. In a word, there is drama. The uninspired "pieces of iron" [satellites] evoke less interest. But today I would like to suggest that we speak about those very things—the direct "descendants" of the first satellite.

A.I. Dunayev: I agree, and all the more so because I do not consider the topic boring at all. I think many of your readers may not even suspect how much poorer our life would be without the satellites, how much science, the national economy, and civilization would lose without them. Yes, I included civilization, too, but I will talk about that a little later. It was no accident that I named science first. An eighth special biosatellite is already circling the planet; SOTSIALISTICHESKAYA INDUSTRIYA has written about the research that is being conducted aboard it, so I will touch upon the main points only. It is these pilotless craft that paved the highway for man into space, that helped explain how the body adapts to an environment it is unaccustomed to, and that enabled us to extend the duration of flights to almost a year.

From time to time, we forget that, in fact, we live at the bottom of an ocean of air and that we are extremely dependent on the processes that occur in it. Grandiose spectacles of nature break out in the upper atmosphere: streams of charged particles and radiation coming from the sun interact with plasma and with the earth's magnetic field. Echoes of these storms reach us and have a substantial effect on human life. In conjunction with the oceans, the atmosphere is responsible for hurricanes and typhoons, for droughts and floods. The satellites, however, provide scientists with an enormous volume of information on the upper layers of the atmosphere, on the ionosphere, and on weather-forming processes.

Lomanov: Ah, we have gotten to weather. Accurate forecasts these days are practically impossible without satellites; without information collected in space, meteorologists feel helpless. Incidentally, many scientists feel that pilotless craft in general provide science and applied fields immeasurably more data than do the expeditions of the cosmonauts.

Dunayev: I would not compare the two: each has its own purpose. I will give you an example. Space interests engineers with its weightlessness, with its "free" vacuum, with the abundance of solar energy. Crews aboard orbital stations have already produced high-quality semiconductors and crystals, unprecedented alloys, and extremely pure biological preparations. Cosmonauts are developing technological processes that will later be used in a program involving automated shops. It is true that units such as the Splav and the Zona are in operation on automatic craft of the Cosmos series; they produce experimental samples of semiconductor materials. Man's participation, however, is advisable in the development of space technology.

Now about the weather. Soviet Meteor satellites have been circling the planet for more than 15 years now. In a single orbit, they "examine" an immense area, one that is equal to a fifth of the earth's surface. Forecasts and scientific meteorological research also draw data from the American NOAA and GOES satellites, the Japanese

Himavari [Khimavari] satellite, and the Western European Meteosat satellite. Satellites tell us about the condition of land and water masses, about the cloud cover, and about temperature anomalies, and they report on extreme phenomena. They help meteorologists make forecasts that are more accurate.

And you recall that 2 years ago data collected by Cosmos-1500 helped to free the vessel Mikhail Somov from icy captivity. Maritime vessels and aircraft have long oriented themselves by man-made stars—satellites of the Tsikada system are used for navigation in our country, and Glonass, a more advanced system, is being developed.

Lomanov: Aleksandr Ivanovich, you mentioned that without satellites civilized life would become impoverished...

Dunayev: Well, is it not so? Don't the Molniya, Raduga, Gorizont, and Ekran satellites, along with the Orbita and Moskva ground stations, "light up" TV screens in the remotest of places? As a matter of fact, television broadcasting via satellite erases the concept of "the provinces," and people can immediately find out about the latest events, can see the same concerts and performances that residents of metropolitan centers see, can hear the addresses of well-known figures of culture, science, and education. And satellite television links [telemosty] make possible a direct dialogue in which representatives of different countries seek points of contact: need it be said that they enable mutual understanding and bring peoples closer to one another? By the way, it is not just the "electronic press" that uses space communications extensively—by transmitting photocopies of newspaper pages to remote areas, satellites also help you, newspapermen, to be more current in your work. At this point, it is hard to imagine today's communications existing without satellites, and by the end of the century, the percentage of the exchange of information via satellite will grow to 50-60 percent from 30.

Lomanov: Cosmonautics actually helps solve many problems of the national economy—there is no longer any need to be convinced of that. But the opinion still exists that cosmonautics is expensive, that the expenditures on it are not commensurate with the outcome. Is that so?

Dunayev: Well, let us try and convince the skeptics. In the television we were speaking of, the savings achieved from using space-based equipment, as opposed to the usual methods of relay, amount to more than 100 million rubles a year. Using satellite photos in mineral prospecting can lower certain of the costs of geological survey operations by 15-20 percent. Satellite cartographic materials reduce the expenditures for various field investigations considerably. Satellites help in monitoring agricultural lands and forest reserves, in predicting harvests, in conducting fishing-industry reconnaissance, in detecting forest fires, in keeping track of snow melt...

Lomanov: Our newspaper has written about these "jobs" more than once...

Dunayev: Then we will not tire the reader by enumerating them. In fact, enumerating them is impossible—the permanent state system now being established in our country for studying natural resources from space can solve hundreds of real problems that are important to the national economy. Of course, the effectiveness of information gathered from space is determined, in large part, by how we deal with that information on earth. And here, admittedly, much needs to be done.

Lomanov: Besides, not everything can be, or need be, measured in money. For example, the lives of those saved with the help of satellite reconnaissance [orbitalnyy patrol]. Satellites help disaster-stricken maritime vessels, airplanes, tourist groups, and expeditions.

Dunayev: Yes, the tragic statistics of Lloyd's, which record shipwrecks, are now being countered by optimistic, continually growing figures that characterize the results of the international KOSPAS-SARSAT system. The system's polar-orbit satellites receive radio signals from emergency radio beacons that make it possible to determine the coordinates of distressed vessels. This system has helped save more than a thousand individuals—citizens of various countries.

Lomanov: Nevertheless, let us return to economics. At a time when entire branches are switching to economic accountability [khozraschet] and are actively moving into the world market, cosmonautics, apparently, is not being left behind. All the more so, as I have encountered more than once in your addresses the, frankly speaking, not-so-customary term "kosmicheskiy rynok" [space market].

Dunayev: Maybe it is not customary, but it is in our time completely natural. Thirty years of experience in the development of cosmonautics, linked with the creation of a mature space industry, has made it possible for us to carry out profitable collaboration on a commercial basis.

Lomanov: With what kind of production can we enter this market?

Dunayev: Information on natural resources, services that involve putting research and natural-resource-survey [prirodovedcheskiye] craft into orbit, information exchange via television [teleobmen], the leasing of Gorizont communications satellites in geostationary orbit—we are prepared for a wide range of commercial contacts. We are conducting negotiations with dozens of organizations abroad, some of which are international organizations. The primary factors determining the expansion of the space market are the use of pioneering scientific achievements, advanced technology, and high level of

economic efficiency. We can expect that by the beginning of the next century, almost the entire world society will be consumers of space production, and the volume of space "services" will grow a hundred-fold.

Lomanov: Those are attractive prospects. However, I would like to remark that our country has always been the initiator of collaboration in space—and not just on a commercial basis. On the eve of our anniversary, it is appropriate to recall at least the main landmarks on this path.

Dunayev: All the more so, as the first examples here were satellites. I have in mind the geophysical research program begun in 1962, INTEROBS, in which seven socialist countries—later joined by Italy, Finland, Sweden, Holland, Spain, and France—participated. In general, collaboration is an immense topic. Judge for yourself—13 joint manned flights; the largest international project, VEGA; more than 20 satellites in the Intercosmos series; 11 Vertikals; and a multitude of Cosmos craft. Nearly 40 countries today use the Intersputnik space communications system, which has been in operation since 1971, and preparations are near completion for a multilevel, international experiment involving the study of Mars and its satellites in the Phobos program. You cannot count them all...

Thirty years ago, the Russian word "sputnik" entered the international vocabulary. It entered that vocabulary with a new meaning—a vehicle that circles the planet. Today, these vehicles link us by telephone with other telephone users who live thousands of kilometers away, they relay television programs, they save lives, they monitor atmospheric pollution. The original meaning is returning to the word, for these vehicles have indeed become reliable companions of man, making our lives easier and embellishing them. 13227/06091

Academician Barmin Interviewed on Early Days of USSR Space Program

18660010 Moscow IZVESTIYA in Russian
29 Sep 87 p 3

[Interview with Academician V.P. Barmin, Hero of Socialist Labor, by B. Konovalov, science reviewer for IZVESTIYA: "Lessons of the First Satellite"]

[Text] Konovalov: Vladimir Pavlovich, an entire generation has grown up and has come of age since the first satellite was born. In your view, what lessons can those who will soon be the principal driving force of our society gain from the development of that first satellite?

Barmin: The main lesson is to believe in the creative energies of Soviet scientists, engineers, and workers. These days, a worship for everything Western is too prevalent among us.

You are at a loss when you read in the newspapers that our domestic technology fails to receive the Quality Award [Znak kachestva] simply because there are no such technologies abroad! Do you really think we would have been victorious in the war if we had waited for the Germans to develop technology comparable to, say, our katushas [rocket guns], whose assembly-line production was organized by the plant Kompressor, where I worked then as chief designer? Could we win the "space race" against industrially and scientifically developed America if we did not rely on our own intellect, our own technology, our own industry?

There is no shame in learning. You must be acquainted with everything that was done before you. After the war, we were fairly familiar with what Germany had done. But the Americans knew about all of that in greater measure. In the autumn of 1945, enough assemblies and parts to assemble hundreds of V-2 rockets were delivered to the United States from Germany, from an underground plant in Thuringia. All the leading German rocket scientists, including senior designer Werner von Braun, also ended up in the United States. He headed the development of the booster used to launch the American satellites. But the first American satellite, Explorer-1, was launched 4 months after ours, and it weighed only 8.3 kilograms—10 times less than ours.

You often hear people say that we were surrounded then by American bases and atomic-bomb-equipped bombers, which could at any moment destroy our country, and the United States would remain invulnerable, unless we developed an intercontinental missile. Of course, militarily the question then was "Will Russia remain in existence or not?" Now we are second to none militarily. But are we not now faced with the question of "existing or not existing" from an economic point of view? Do we not need to rapidly restructure the economy, science, and technology? And here we must bravely walk unbeaten paths.

When S.P. Korolev began his advanced work on long-range rockets, he rejected the design scheme of the German rocket known to us as the V-2, which remained a single unit from start to finish. He proposed separating the payload from the rocket, once the rocket had performed its mission, so that the payload itself could travel farther. This provided a number of advantages. The concept for the R-7 rocket, which put the first satellite into orbit, was also independent and original.

Konovalov: At one time, much was written about the Russian "rocket secret," the unusual fuel, and other mysteries. Really, it is astonishing that, in all, 12 years after the most destructive war in our history, when we had to use every muscle to rebuild our economy—and suddenly this breakthrough to the leading edge of science and technology...

Barmin: If there was any secret, it was perhaps in operational organization. The task, you see, was complex and involved interbranch operations. The development of rocket complexes required effective collaboration among many design bureaus in various ministries. The operational front was broad.

Chief designers were appointed for the principal engineering areas, and a single agency was formed to administer all engineering policy. These days it is widely known—the Council of Chief Designers. There were six of us in all: S.P. Korolev, V.P. Glushko, V.I. Kuznetsov, N.A. Pilyugin, M.S. Ryazanskiy, and myself. The leader, the council chairman, was Sergey Pavlovich. None of us at that time had any scientific degrees. We were simply engineers, experienced and knowledgeable, each of whom headed his own design bureau, but, let me emphasize, merely engineers. Back then, the engineering profession itself and the work of an engineer were still valued highly.

The council's meetings were usually held in the design bureau whose field was the topic of discussion. If, for example, the discussion centered on engines, the meeting would be held in V.P. Glushko's bureau; if it was on ground equipment, the meeting would be held in our bureau. But S.P. Korolev always presided. If we had to, we would invite specialists in to discuss a specific question. But we always talked things over amongst ourselves and reached a decision that was agreed upon and approved by all. If there was any disagreement, the deciding word was with the chief designer whose field was the focus of the meeting. And we never, I should emphasize, never turned the council into a trade-union meeting of sorts, in which the decision was made by a mechanical majority of votes.

Konovalov: To put it into today's terms, did a clear-cut, systems-oriented approach hold sway in your work, and were decisions made by the developers themselves?

Barmin: That is absolutely correct. Each of us headed a design bureau, had the authority in his own area, and could implement decisions. Of course, far from always did our ministry leaders like it, and there were conflicts. As a result, S.P. Korolev later succeeded in securing a resolution whereby the decisions of the Council of Chief Designers were binding for all ministries and agencies.

And of course, from the very beginning we used systems analysis in our design work. Moreover, in spite of the formal demarcations, the entire organization of operations, ranging from designing concepts to putting something into operation, was united by a single schedule that ran through the project. All operations and the interagency cooperation were carefully controlled. The chairman of the State Commission for Testing Boosters and Launches of the First Satellites was V.M. Ryabikov, a man who did much for the formation of domestic rocket-building.

All operations were conducted in parallel. The design and manufacture of parts were done while the design sketches were released. Test stands were prepared at the same time that assemblies were being developed. Was there an element of risk? Yes. But the person who does not take a risk is the one who is afraid to take responsibility.

The interrelationship and interdependence of the operations made missing a deadline in any section unacceptable. For that reason, every director and participant—from the chief designer to the shop master—in assessing the status of the work in his own area, considered the schedule above all as, by and large, the ultimate end and immediately sounded the alarm if there was a threat of a missed deadline. The feedback worked flawlessly. Any danger of missing a deadline went, like an alarm, immediately to the Council of Chief Designers, to the proper ministry or directing agency. In every serious instance, aid was rendered without delay. Depending on the circumstances, the aid might be people, equipment, finances, or additional production power.

I think it very significant that the work deadlines, although tightly compressed, were realistic, because they were established by the equipment designers and makers themselves. In my view, nothing so dampens one's ardor as when deadlines that are known to be unrealistic are assigned. And conversely, the press of a tough, but realistic assignment forces the matter on. Our domestic technology moved ahead in sort of small steps, improving from rocket to rocket, but on the whole it went very quickly.

Konovalov: Could you give us an example of the successful interbranch cooperation among the designers in the different bureaus in developing the first satellite?

Barmin: As many as you like. That the entire country developed the satellite is no empty phrase, but rather a reflection of what really happened. Every one of the principal design bureaus, you see, had the cooperation of dozens and even hundreds of scientific-and-technical and industrial organizations, and without their participation we could not have solved our own "individual" problems.

And of course, the principal design bureaus worked especially closely with one another. When the R-7 was being developed, for example, the design bureau of S.P. Korolev at first suggested abutting the rocket against the launch pad. This required that the rocket itself be more durable, and five exhaust outlets had to be made. The launch structure itself ran the risk of being damaged from an initial, even if small, deviation of the rocket from the design trajectory. The combined creative work of our bureau and Korolev's gave birth to the idea of suspending the rocket "by the waist," above the center of gravity, on specially designed structures of the launch system. A heavy rocket "hangs" on them until its engines go into primary thrust mode. And then they pull away to

the side simultaneously, and the gas blasts from all the operating engines exit in one large opening and escape to the steppe through a special concrete conduit. This original, clever, and reliable launch structure performs wonderfully to this day for the launch of satellites and cosmonauts.

Konovalov: Vladimir Pavlovich, from the very beginning, you were one of the most active participants in the creation of the Baykonur cosmodrome. There are many legends about its genesis. In particular, the choice of the site is attributed to S.P. Korolev. Is that so?

Barmin: No. We began working on the first postwar domestic rockets in the region that is now known as the Kapustin Yar cosmodrome. When the question of developing an intercontinental missile came up, a new cosmodrome had to be created. A working commission for choosing the site was set up. S.P. Korolev, M.S. Ryazanskiy, and I were enlisted for the work as consultants. Three possibilities were presented. The first was in the Mari ASSR, where, after the clearing done in the war years, there were immense open spaces. It was suggested that additional clearing be done in the flight path of the rockets on account of lumber deliveries. The second site was in the vicinity of Makhachkala, on the shores of the Caspian. The discarded stages of rockets launched from this site would fall in the Caspian. The third possibility, which was considered by the commission to be the least preferable because of climatic conditions, was in Kazakhstan, in a semiarid area adjacent to Syr Darya. G.K. Zhukov reported to the government on this site. The Kazakhstan site was chosen.

Konovalov: What are the most vivid impressions that remain with you from the days when rocket and space technology was first being developed? What must we use now in the course of the restructuring that is going on in the country?

Barmin: The main thing I remember is the enthusiasm. We worked like people who do not work for any kind of money. We worked in the name of a lofty ideal, we worked for the motherland. At Kapustin Yar, we lived in train cars, and no one counted the hours or thought about the workload. As they used to say, we toiled "without thinking about our bellies." That is the kind of thing that is not forgotten. The harder a victory comes, the more memorable it is.

Enthusiasm, discipline, responsibility, conscientious work were absolutely necessary. I warmly welcome the changes that are going on in the country. We accumulated too many negative things. The main thing, in my view, that we have to change, that we have to do is to restore the prestige of the engineering profession.

And besides that, we have to believe in success. No matter how hard it is. We have more than once proven that we can burst ahead. In my opinion, we must devote

more attention to the management itself of the restructuring, we must avoid trite solutions, we must try different variations. Along with the large-scale goals, it would be useful for every enterprise to outline small, clear-cut stages for executing all matters. When even a small matter is accomplished, it inspires people, and they begin to firmly believe that they can accomplish the larger matters, too. It is like a unique chain reaction—success gives birth to success. 13227/06091

Organizational Framework, Working Atmosphere for First Satellite Launches Recalled

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[Interview with B.Ye. Chertok, USSR Academy of Sciences corresponding member and recipient of the Hero of Socialist Labor award, by B. Konovalov, science reviewer for IZVESTIYA: "Dash to the Stars"; first paragraph is IZVESTIYA introduction]

[Text] The launch of the first satellite of the Soviet Union stunned the entire world. Many simply did not want to believe that our country had passed the leader of the Western world—industrially strong, developed America. We chatted today about how that came about with someone who was a long-time comrade of S.P. Korolev and one of the people who played a role in the development of the first artificial earth satellite in the history of mankind and the rocket that launched it.

Question: Boris Yevseyevich, what, in your opinion, 30 years ago dictated our unprecedented success?

Answer: That success has a great many components. The main one, in my view, was the great spiritual upsurge that reigned in the country then. The satellite was developed by a generation of victors. We had taken upon our shoulders the most difficult years, we had crushed Fascist Germany, and everyone was certain that we could develop a technology better than the West's. One should not forget that in the pre-war years, Germany was the embodiment of the leading scientific and technical thought of the capitalist world. We still overcame her, thanks not only to the courage and heroism of our troops, but also to the growth of our industrial strength, to advanced technological ideas, and, of course, to the selfless labor of all our people.

"On inertia," in the best sense of the word, we labored just as selflessly and with just as much inspiration to develop the field of domestic missile-building. I can honestly say that the level of effort was no less than during the war.

Much is being said right now about material incentives. That is understandable. They were also operating back then. We were not indifferent, and, of course, we wanted to live better in material terms. I, for example, although I had a fairly high post, lived with my family in a communal apartment. It is likely that half of our design

bureau was on a waiting list for a room—not an apartment, I want to stress, but a room. The bonuses were relevant for us. All the work had been broken down into specific stages. And we well knew that material gain awaited us if we met an assigned goal on time. But that was not the most important thing. The primary driving force was patriotism. We were not afraid of that lofty word, and service to the fatherland was held in esteem. The international situation itself urged us on, forcing us to not forget for a minute about the safety of the homeland. The dangers were not invented dangers. President Truman had approved a plan for a nuclear strike against the Soviet Union. He could pounce on us at any moment. Our generation had first to eliminate the United States' monopoly of possessing atomic weapons. And then we had to develop a missile force that would not allow an atomic attack on the USSR to go unpunished. And we worked above all for the safety of the homeland, which had just gone through a terrible war in which the country had lost 20 million of its sons and daughters.

Yes, we developed military rockets. But S.P. Korolev was always thinking about how they could be used peacefully. A modified version of the very first rocket developed under his direction was used for studying the upper layers of the atmosphere. And an intercontinental missile put the first satellite into orbit.

Now, though, we are seeing the reverse. The United States wants successes achieved in the peaceful development of space to serve military aims. How sad, but it is a fact—the planet faces the alternative of “star peace” or “star wars.” Maybe this is naive, but I personally still hope that reason will win out and space will not become an arena for military confrontation.

Question: The development of a domestic missile-building industry is an interbranch task typical of the many that face our country right now, but their completion is meeting serious difficulties. In what ways, in your opinion, can the space industry's past be useful today?

Answer: You should not think that everyone immediately recognized the importance of rocket technology or saw the scale of the job. In 1946, I witnessed a typical episode. D.F. Ustinov, who was minister of armaments at the time, after becoming acquainted with the technology of the German V-2 system, asked one of the chief artillery designers, “Can you make such a system?”

The designer, after only a moment's thought, replied, “I can, Dmitriy Fedorovich, but only if you give me 20 electricians.”

It was said so seriously that Ustinov, who by then was familiar with our suggestions about setting up a new industry in the country, sincerely roared with laughter.

In fact, a great many earnest people back then thought of the rocket as little more than a large artillery shell. S.P. Korolev was a hot-tempered man, and such remarks enraged him.

All his preceding fortunes had prepared him better than, perhaps, anyone else to develop a rocket technology, and he understood well that it would require broad cooperation and that the bureaucracy would have to be overcome.

An “administrative-command” or “directive” style of control, as they are given to say today, held sway in the postwar years. During the war, I am convinced, that style was vitally necessary. But it went on into peacetime. It is true that back then it was not as bureaucratic as today. Most of the party and state figures had the intention of helping the technology developers in every possible way, not blocking them with directives, instructions, prohibitions, or incompetent advice. V.M. Ryabikov, D.F. Ustinov, V.D. Kalmykov, K.N. Rudnev, and others did a great deal to set up a domestic missile-building industry. If we had had to spend months in the bureaucracy collecting dozens or even hundreds of approving signatures and permits, then of course we would have never been able to develop anything in a short period of time.

Today's restructuring [perestroika] is badly needed by the country because the bureaucracy, which in essence has become interested only in updating its own well-being and which impedes matters, has become extremely powerful. It has gained strength from generation to generation. The bureaucratic style of operation has become more and more intricate and refined. This explains the fact that the mechanism for accelerating things, which, without a doubt, operated in the postwar forties, fifties, and, to some extent, sixties, has been replaced by a mechanism for impeding. The situation is similar to making a steep ascent up a mountain: if you fail to shift gears in time, the motor will begin to choke, and the car may even roll backward. We started shifting a little late, and so we have to shift so much the more energetically.

Under S.P. Korolev's direction, a real mechanism for accelerating things took shape. And his own “brain trust” was an informal council of chief designers who solved all the principal problems themselves and asked the chief apparatus for help only when they had to. Academician V.P. Barmin has spoken in detail of his leadership. I simply want to emphasize that there were no official decisions of the government agencies on the rights and status of this council until 1961. Nevertheless, this informal group wielded extraordinary authority and, in essence, made for the success of interbranch cooperation.

Of course, an enormous role was played by the personality of S.P. Korolev, who was not only, without a doubt, a great designer, scientist, and manager, but also a leader of state who consolidated and directed the overall efforts

of hundreds of organizations. Sergey Pavlovich did not much care for the term "smezhniki" [factories producing components for main manufacturer]. What he needed was not smezhniki, who work together according to resolutions and orders "from here to there," but like-minded allies and enthusiasts. And he could find them, in spite of his rigid, demanding nature.

Many problems never made it to the level of the chief-designer council. Below each of the designers was a competent "second echelon" of management that consisted of deputies who themselves were outstanding people. Suffice it to say that that second echelon (only some of whom, unfortunately, are alive and well today) produced 6 academicians, 8 corresponding members, and 19 Heroes of Socialist Labor.

And reigning among all the participants in this cooperative effort were honest, businesslike relations that were based above all on decency. Settling a complex question took simply a visit or even a phone call. And if someone gave his word, it never occurred to him to go back on it. When difficulties arose, people did not hide them, they searched out solutions together.

It must be said that such interagency cooperation operated not only in missile building, but also in solving problems of a scientific nature. A scientific council for the study and development of outer space was set up; Academician M.V. Keldysh headed it. The council also overcame agency "partitions"; and the space programs were complex, they had precise, step-by-step goals, and they were achieved in close coordination with the development of our technology.

Question: Rocket technology is a complex field. Thirty years ago we wrote little of the difficulties it found in its path. Let us look back and examine how we overcame our failures. After all, a chronicle of one's failures is no less instructive than a list of one's successes.

Answer: Yes, victory did not come overnight. During the first launch of an intercontinental missile on 15 May 1957, a side unit of the first stage burned. On the second launch, in June, the guidance system failed. We postponed the third when the rocket was already fueled because of problems that were detected on the ground. But no tragedies came of any of this. No one tried to frighten or punish anyone. They merely used all their energy to search for the cause of the failure and eliminate it.

When the guidance system failed, for example, Sergey Pavlovich said to me, "Go to N.A. Pilyugin's and sit there until you find the answer."

He always demanded a scrupulous analysis of the causes of the failures, and more often than not he personally scrutinized the investigation. Sometimes right at the start he was next to the fueled rocket, ignoring pleas that he step away and not risk himself. His meticulousness helped things out.

Sergey Pavlovich hated the evasive formula, "The probable cause of the failure is..."

"You need to dig out an unequivocally established cause, not a probable cause," he would say over and over again.

To his subordinates, Korolev was always a demanding, formidable chief. But whenever an unsuccessful launch brought his friends on the council of chief designers or his close associates under attack from superiors, he "called the fire in on himself."

"This is a learning process," Korolev would say, "in which failures are unavoidable. The honest analysis of them enriches our experience much more than would an unbroken chain of successes."

We were on an accelerated schedule of flight tests because of a lack of time. The situation in the United States was similar. At the very outset, they chose a course with a simpler goal—to launch a small satellite weighting 10 kg or less (for that reason, they called it an "orange"). Nevertheless, in the Vanguard project, which was headed by Werner von Braun, the V-2 developer who had been brought to the United States, only 3 of 11 rocket launches were successful. Our statistics were better—four of our first seven launches were crowned with success.

On 21 August 1957, our intercontinental R-7 reached its designated target region in Kamchatka. After that, all our energies were devoted to the launch of satellites.

And here it is necessary to note one of S.P. Korolev's characteristic traits. He was a very brave man, and he knew how to assess a situation soundly and defend his position with no fear of wrath from above. By a decision issued 30 January 1956, we were to launch in 1957 or 1958 a 1,400-kg satellite on an intercontinental missile that was being developed. That satellite, which was designed with the active participation of M.K. Tikhonravov, was to be an actual scientific laboratory—with up to 300 kg set aside for research gear. But Korolev saw that the task was complex and that we would not be able to manage the deadlines and would lose our preeminent position because of the simple fact that the Americans had put its tiny satellite into orbit.

He proposed a wise solution: launch two very simple satellites first. Far from everyone agreed with him. Even Academician M.V. Keldysh objected at first.

Only after the launch of our simple satellite, when we saw the immense political resonance it had in the world, did everyone understand how correct and farsighted Sergey Pavlovich was.

Question: What, more than anything else, sticks in your memory about the atmosphere of those days?

Answer: The enthusiasm. The fervor. It was as if our eyes were suddenly opened and we clearly understood that we had done a great thing. And Korolev then established a new daring goal: to build a second satellite in a month and launch it into orbit with the first living being—the dog Laika. The equipment we had was, by today's standards, comparatively simple. But our enthusiasm was colossal. We all worked without having to be urged on. We wanted to be sure of launching the second satellite by the 40th anniversary of the October Revolution. This was very difficult. Here is a typical detail from that time. Korolev went to the leading satellite designer, M.S. Khomyakov, and said, "Are you going home?"

"Yes."

"Let's do this. Take my car and go tell your wife that they are sending us on assignment, and then come back and work at the shop."

The work, of course, was selfless, and the homeland awarded us generously for it. In our group alone, 5 people received the Hero of Socialist Labor award, and 11, the Lenin Prize. Five hundred workers were awarded orders and medals.

And another quality of S.P. Korolev should be mentioned here—he saw to it that all our partners were generously awarded, perhaps even at the expense of his own organization.

"If we do not see to it," he said to us, "who will? We worked together, we must share the success together."

He blocked all attempts at chauvinism by the head organizations, which, unfortunately, are accustomed to raking everything to themselves:

After we had received a generous number of awards, Korolev gathered everyone and said, "Now we must carry out the original project—developing a heavy satellite equipped with scientific gear. We have a month to do it. The scientific gear is already ready."

By today's standards, that deadline would be utterly fantastic. But we met it!

"Let's break with tradition," Sergey Pavlovich said. "We will work this way: no one will wait for anybody else. No one will wait on any design or drafts. The project designers, the other designers, the industrial workers, the engineer—the developers of the scientific gear will be moved to the shops, and everyone will work together. Let the project designers lay out their ideas in the presence of the shop foremen and the workers; let the other designers make their sketches here, too; and let the engineers and workers make their corrections immediately—and we are in business."

And in that heroic group effort, the third satellite was born.

Question: This year, we celebrate two anniversaries at the same time—the 80th anniversary of the birth of S.P. Korolev and the 30th anniversary of the launch of the first satellite. You have already told us much about Sergey Pavlovich. Can you give your personal assessment of his role in cosmonautics? He is known to have thought a lot about the future. How are his visions being carried out today?

Answer: Korolev was a multifaceted individual and an extremely brilliant man. In cosmonautics, he laid the foundation and took the first steps. But he never forgot the role played by his predecessors, above all, the role played by K.E. Tsiolkovskiy. He helped the Kaluga organizations quite a bit to erect a memorial museum to Tsiolkovskiy. In general, he tried very hard to see to it that none of the pioneers of rocket technology were forgotten. He searched out the grave of F.A. Tsander in Kislovodsk and got his remains re-interred in a more visible spot and saw to it that a monument was erected.

Korolev was always not only the Chief Designer of Rocket-and-Space Systems, but also, in essence, the creator of a new industry. His official approach to matters was often in conflict with the private interests of the people in his own group. We had done a large amount of work involving interplanetary vehicles. And he transferred the entire field to G.N. Babakin's group. Korolev had to convince the government, us, and Babakin himself that it should be that way. And Sergey Pavlovich knew how to do it. We were the first to build the Molniya communications satellite. And it seemed that we would develop it further. But Korolev understood that communications satellites are a large-scale venture, and he managed to transfer them to another design bureau. Our group was made into four design bureaus. Korolev was categorically against a monopoly by our leading organization. He understood that we did not want to hand over a project we had started to a "stranger," but he felt that the interests of the state took precedence over ours.

"You must not embrace the unembraceable," he often said. "We have charge of the most important and responsible matter—manned flight."

He thought much about the future, but he wrote little—he did not have time. On the other hand, he loved to talk about it with his closest associates, especially on the cosmodrome, whenever we had a few spare minutes.

He dreamed about man being at home in space. He used to say that a time would come when workers would fly into space on passes awarded by trade unions. That time has not come yet, but it could be the near future, if mankind would stop making gigantic expenditures on arms. Then we could use all our energies to accomplish the most daring space projects. Why, technology-wise, we are already prepared to create lunar bases and carry out expeditions to Mars.

When the new rocket, Energiya, was launched not long ago, I thought, How happy Sergey Pavlovich would be right now. Why, this is a vigorous dash toward the creation of a colonized orbital ring around our planet, something he dreamed of.

The motto of F.A. Tsander, "Onward, to Mars!," had lived in Korolev since before the war, when he headed the Group for Studying Jet Motion [Gruppa izucheniya reaktivnogo dvizheniya]. And the first vehicles to Mars and Venus set out while Korolev was still alive.

I remember how upset he was when he found out that the temperature on Venus was very high and that life could not exist there.

Once he said that he did not want to believe Albert Einstein. His reason told him that Einstein was right—that nothing in nature could travel faster than the speed of light, 300,000 kilometers a second—but his heart did not.

"Even if I do believe him," he would say to us, "man will find some way to fly to the stars. It cannot be that he will not be there."

This realist, this calculating, farsighted individual was, in his soul, an incorrigible romantic.

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Academician Avduyevskiy Discusses Achievements and Future of Soviet Space Program

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[Interview with Academician Vsevolod Sergeyevich Avduyevskiy by L. Nikishin: "Our Path Was Not Strewn With Roses"]

[Text] Question: Vsevolod Sergeyevich, these days the whole world is observing the 30th anniversary of the launching of the first artificial earth satellite and the beginning of the space age. You have been an active participant in all stages of the operations involving our country's space program. How do you look upon those 30 years? What sticks in your mind about that course with all its ups and downs?

Answer: The most important result of the past 30 years, I believe, is that cosmonautics has become an integral part of our lives. Historically speaking, it is a brief span of time, but it is hard now to even imagine a time when there was nothing in near-earth orbit. If satellite communications, satellite navigation, and satellite meteorology were to suddenly disappear, people would experience substantial inconveniences. The work of the cosmonauts that spans many months aboard orbital stations is looked

upon as nothing out of the ordinary. Meanwhile, the nationwide rejoicing that went on over Yuriy Gagarin's flight, which lasted a total of 108 minutes, is still vivid in people's memories.

Our country's space program has always been distinguished by consistency and peaceful aims. That is not simply an empty phrase: not 1 year of the past 30 has been easy, but each has been a step forward. Much of what was done in that time span has been described in books and articles; it is hardly my intention to repeat all that, but as an active participant in those operations, I have my own impressions and assessments.

The beginning of the space age was a time of well-coordinated, goal-oriented work in a totally unexplored area. It was a time of astonishing organizational and human relations among those who were doing that work. The pace of scientific and technical progress was itself unusual, and setting that pace was an unusual individual who stood in the center of events—Academician Sergey Pavlovich Korolev, the Chief Designer, as the journalists called him then, jealously keeping his name a secret. Right next to him was a young academician, M.V. Keldysh, who also bore an unusual name in the press—the Theoretician of Cosmonautics. The alliance of these individuals was absolutely necessary then: missile technology could not have been created without science, and, at the same time, it was developed in the interests of science.

How could they possibly develop something if, as it were, there were not even any methods for designing its components? But this question, for some reason, never occurred to anyone. And it turned out that they were able to develop what they set out to, because they created methods of design right then and there, as they worked, and they were always ready to meet whatever deadline was necessary. Later, in the 1960's, networks became the rage, and then everything somehow came together on its own. But did it really come together on its own?

I remember, in 1953 various heat-shield coatings that were to prevent spacecraft from severely overheating upon entry into the atmosphere were developed and tested. Our group of young research-institute associates came up with a new idea for facilitating the development of a heat shield. We immediately went to the design bureau headed by Sergey Pavlovich. And by chance, we met him on the plant grounds, as he was returning from a shop. We spoke as we walked—it took Korolev only about 5 minutes to get the gist of the idea and to make some observations on its development. Within a half an hour, the designers were already working on the idea. And that is how it always was. Nobody ever ran into any kind of bureaucratic delay with Sergey Pavlovich, and there were never any problems of "implementation." All ideas worth doing were snatched up instantly and were quickly converted into designs, and trust of and good will toward those enthusiastic about their own work was the rule. That was the primary incentive that inspired the

participants in this collective work, and there were many of them. Industrial and academic institutes and enterprises did not solicit the decisions and resolutions of higher agencies—they went straight to the chief design bureau and performed complex theoretical and experimental operations within schedules that spanned only months.

So, we had the experience of accelerating things even then. And the results of such an approach to business were not slow to show up.

Work on the development of the first intercontinental ballistic missile began in 1953. In 1955, the decision was made to build the Baykonur cosmodrome in the Kazakhstan steppes. The first successful launch of the missile was in August of 1957. On 4 October, the world's first artificial earth satellite went into orbit, and 3 and 1/2 years later Yuriy Gagarin made his triumphant flight. That wound up the first stage of the birth and formation of cosmonautics, during which, in a matter of just a few years, plants were erected, new materials and technologies were developed, a huge cosmodrome was built, and a network of ground-based tracking stations was set up...

This phenomenon cannot be attributed to immense capital investments. They were in fact very limited, and everyone knows anyway that large amounts of capital do not always ensure success. The acceleration occurred as a result of the enthusiasm of the individuals involved, the direct communications between enterprises, the honest performance of duties by all those who were involved in the operations, and the absence of bureaucratic obstacles and red tape.

The growing complexity of the tasks associated with the development of space and the need to set out on distant interplanetary paths required the creation of a more powerful booster. The work was assigned to a different design bureau, headed by chief designer V.N. Chelomey. This was a fundamentally new rocket that used not kerosene or liquid oxygen, but fuel components with high boiling points. But it was also developed in a fairly short period of time—about 5 years; the vehicle and its computerized launch were ready in 1964, and a scientific complex weighing 15 tons was placed in orbit the following year.

Thus, in less than a decade, the Soviet Union transformed itself into a formidable space power. The acceleration had nothing to do with any lowering of the quality or level of equipment. Why, the booster that lifted the first satellite (its three-stage variation was named Vostok, and it put the first spacecraft into orbit; when it was later modified, it was named the Soyuz) is being used to this day, 30 years after its development, for carrying various payloads, including all the manned Soyuz craft. Nor is the Proton booster ready to "retire on a pension." These rockets will serve Soviet cosmonautics for a long time to come. That is an enviably long life for designs manufactured "with an ax," is it not? It might

have been possible not to focus attention on these hostile, stupid attacks were they not met so often in the Western press. By the way, the Proton rocket, for example, is far superior in terms of technical characteristics than the American rocket of the same class, the Saturn-1B.

Incidentally, launching the American Space Shuttle, with a cargo of about 20 tons, costs \$220 million; whereas launching the Proton, carrying 20 tons, is nearly 10 times cheaper (including the cost of manufacturing the rocket itself).

And there is another stage in the development of domestic space research that I would like to note. It has to do with using spacecraft to study the moon and the planets of our solar system. In the early days, all the work was done in S.P. Korolev's design bureau: his engineers designed the Vostoks and the Lunas as well as the first Veneras and the Mars spacecraft. But Sergey Pavlovich had no intention of becoming a "space monopolist." In 1965, after pointing his own group exclusively toward the development of manned craft, he gave the operations on automatic stations over to the design bureau headed then by G.N. Babakin. In 1966, the Luna-9 craft made a soft landing on the moon and transmitted back to earth the first panorama of the lunar surface. Soil from the moon, the operation of the lunar rovers, the landing of automatic stations on the inhospitable terrain of Venus—all were the achievements of those who took the baton from the founder of applied cosmonautics. The service they performed is that within just a few years, our country assumed the leading position it still occupies in the world in Venus research—research, by the way, that is very difficult, considering the fact that the surface of Venus has a temperature of up to almost 500 degrees and atmospheric pressure that is 90 times greater than the earth's.

Our country's development of orbital stations also went through several stages. The first generation of Salyuts had limited potential because the resources cosmonauts needed in order to live and work were nonrenewable. The second generation—the Salyut-6 and Salyut-7, which were equipped with two docking units—made it possible for cargo craft to supply the crew with everything they needed. The potential was expanded considerably. In orbit now is the third-generation station Mir, to which several special modules may be docked. One of them—the astrophysical module Kvant—is already working as part of the station.

The time has come for introducing a universal, heavy-duty booster rocket. We have already conducted the first successful test of the Energiya rocket, which is capable of putting more than 100 tons into orbit.

The perestroyka [restructuring], the acceleration, the glasnost [openness], and the elaboration of democracy that are now under way in all sectors of our society have a bearing on activities in the realm of cosmonautics. As

it turns out, of course, cosmonautics is a catalyst for scientific and technical progress, for discoveries, and for new technologies in all the branches of our economy.

Of course, the path of our country's cosmonautics has not been carpeted with laurels only; there have been interruptions and errors that have sometimes led to failures and mishaps. We honor the memory of the fallen cosmonauts who gave their lives for the future of mankind. But the main thing is that we have taken stock of the lessons of our failures and errors and we have garnered the experience we needed. The strict norms that have been introduced for finishing work and checking it have made it possible to achieve a high level of reliability with modern rocket-and-space technology.

Most of the failures, of course, were in the beginning, when, essentially, we did not know anything. When we were developing the first intercontinental missile, we did not immediately grasp, and cope with, the phenomenon of high-frequency vibrations in the engine combustion chambers, which led to their burnout. Longitudinal vibrations in the rocket/engine system caused a lot of trouble. Up until the time when our rocket-and-space complexes were developed, a theory for the reliability of the larger systems had not been thoroughly worked out, and the techniques for the ground-based processing, adjustment, and final checking of equipment and its components were not thoroughly clear. A testing rig was not always ready when the rockets and spacecraft themselves were.

Question: The development of the heavy-duty, universal rocket Energiya solves the important problem of delivering high-tonnage cargoes into orbit. But that does not mean that the vehicles with a smaller freight capacity will disappear, does it? There will probably always be a "fleet" of various vehicles for delivering things into orbit, will there not?

Answer: I have mentioned that Soviet cosmonautics uses boosters with various load capacities. We have the Cosmos medium booster and the heavier Soyuz and Proton vehicles. And now we have a heavy, universal vehicle. And that is necessary.

I would say that we cannot count on any one vehicle as the only means of delivering things into space; that is the wrong way to approach it.

Question: Apart from the brief Apollo flights to the moon by the American astronauts, man has yet to fly into deep space. Rather, he remains near earth, where we have found quite a bit to do. Today, however, the discussion of projects such as a lunar base and a Martian expedition are again opening up. What do you think, has the time come for this?

Answer: Besides the launch of the first satellite, the greatest achievements of cosmonautics are, I think, Yu.A. Gagarin's flight, the development by our country

of long-term orbital stations, the landing of the American astronauts on the moon, and the flights of the interplanetary vehicles to Venus, Mars, and the other planets of the solar system (let me add parenthetically that any talk of who is doing what at what speed—the hare or the tortoise—is at the very least foolish). These achievements have hastened the arrival of the time when bases to which man can fly and where he can work will be created on the moon and other planets. The nearest in the future is the creation of a lunar base. The development of rockets like the Energiya enhance considerably the reality of performing such a task. In my opinion, however, it is still not very clear why we need such a base.

To me, the expedition to Mars seems more important. Our interest in that planet is not casual. For the time being, it is the only place in the solar system, except earth, whose conditions allow us to conjecture about the existence of life or biological activity. Clues to this can most probably be found at specific "oases" near the dried river beds beneath the planet's surface. The unmanned American Viking spacecraft, as everyone knows, did not find any traces of life on Mars, but their opportunities were limited by place, time, and the method they chose to use. In such research, it is difficult to replace man.

The conditions favorable for life at the Martian oases are similar to the conditions on earth on the highest mountain peaks. And searching for life on the "red planet" is so important for the overall understanding of the origins and existence of life on earth that even a negative finding would be worth the effort.

An expedition to Mars would be a very complex, expensive enterprise. The cost, however, would be only an insignificant fraction of what the countries of the world spend for military purposes even during peacetime. Doing such a project would bring about a great leap in the growth of science and technology and would take them to new frontiers. If we were to make this expedition an international effort, it is possible that it could be accomplished even before the end of this century.

Question: Would it be possible today to enhance the applied output of space research? There is a lot of talk about orbital plants, but in fact they are not there yet, and neither is their astonishing production.

Answer: A great deal of information about the earth and the universe is already being transmitted from near-earth space. The orbital systems are constantly being improved, and they are already being used widely in the economy—for studying natural resources, for environmental protection, and, among other things, for weather forecasting.

Satellites have brought about great advances in the solution of problems associated with cartography, and navigation problems have been solved on a practical

basis. Many projects have been made public now concerning the development of orbital systems for collecting solar energy that will be transmitted to earth in the visible range (with lasers) or in the VHF [ultrakorotkovolnovoy] range. There are also projects for illuminating the nighttime side of the earth with huge mirrors in high orbit. All of this is, in theory, possible, although not in the near future. Such projects, of course, require greater in-depth study from the standpoints of technology, economics, and ecology.

There is yet another area of practical application of cosmonautics for which I have great enthusiasm. It is the so-called space technology, which you referred to. Today already a great many experiments are being conducted, and science involving processes in weightlessness is developing rapidly. A number of valuable findings have been made concerning the production in orbit of various materials, primarily improved crystals for the semiconductor industry, as well as ultrapure biologically active preparations.

In my view, however, the enthusiasm for conducting a broad range of experiments has led to the fact that, in essence, operations involving the industrial (or the semi-industrial) production of materials have not yet been started: this represents a definite loss of speed. It seems that interested agencies should be consulted and changes should be introduced into the program of operations that would identify materials that are the most promising from the standpoint of industry, and then efforts should be directed toward producing them in orbit in the needed quantities.

Question: Rockets are being launched almost every day these days, and satellites number in the thousands. It is rumored that, for example, all this affects the weather, that the climate is deteriorating. What do you make of such assertions?

Answer: Ecological problems and the effect man's activity has on nature and climate (which is acquiring a global character) concern everyone.

Rockets that have a great deal of power burn an immense amount of fuel in the very brief period of time that they fly; the exhausted gases often contain harmful substances (carbon monoxide, for example) that poison the atmosphere. But—and I place my hand over my heart when I say this—their total discharge here is thousands of times less than that of automobiles and aircraft.

It is true, the flight of a rocket results in gases being spread over a large area in the atmosphere; in some cases, this can lead to troublesome consequences. Because of the danger of harmful effects from the combustion products of the solid-fuel boosters of the U.S. shuttle craft, for example, the possibility existed that the citrus crops in Florida would be poisoned. The fuel formula had to be changed.

When a rocket passes through the ozone layer, the exhausted gases react with the atmospheric ozone. This leads to local deterioration of the ozone layer, which protects all life on earth from the harmful effects of the ultraviolet radiation of the sun. However, research has shown that this deterioration is very slight and that the "hole" that has formed closes up rapidly. But atmospheric ozone also deteriorates from freon, which is widely used in aerosol sprays, from nitrogen oxides, and from many other man-made products. This has become a sensitive question with the discovery of immense "holes" in the ozone layer over Antarctica.

As far as the satellites themselves are concerned, the radiation emitted by them is negligible, compared with the solar radiation and the radiation of cosmic rays that penetrates near-earth space.

Another matter, however, are the nuclear explosions the United States is planning to make in space in its "star wars" program. Their effect on the ionosphere could disturb the existing balance in the atmosphere and could have pernicious consequences. But that is already another topic.

Question: Will anyone ever fly to the stars? And is it possible for other highly developed civilizations in space to visit earth? They say that unidentified flying objects are their messengers...

Answer: Flights to the stars are, in theory, possible. Rockets using the energy of thermonuclear reactions, for example, can be developed. For now, the solution to the problem of controlling a thermonuclear reaction is a matter of the future, although researchers in many countries are working on it in the hopes of producing for mankind an inexhaustible source of energy. But an engine capable of working for many thousands of years must still be developed.

Here the question involves not so much the technical aspects as the advisability. It is not clear why we need to dispatch a vehicle that would be flying to its target for many thousands of years.

And, as regards messengers from other civilizations...It seems to me that it would be much simpler for other highly developed civilizations in space, if they do exist and if earth is within their reach, to send us radio signals. Scientists are searching for such signals, but they have found nothing so far. But the question of UFO's has been discussed so many times, I would rather not return to that topic. In my opinion, it has nothing to do with the realm of scientific research.

13227/06091

History of Sputnik Project Recounted

18660017 Moscow PRAVDA in Russian 4 Oct 87 p 3

[Article by Yaroslav Golovanov: "The Beginning of the Space Era"]

[Text] Mikhail Klavdiyevich Tikhonravov was a man of unusual curiosity. The mathematics and the many engineering disciplines he mastered in the Academy imeni N.Ye. Zhukovskiy did not dry up his romantic enthusiasm and bent for flights of fancy. He painted landscapes in oil, assembled a collection of wood-eating beetles, and studied the dynamics of flight in insects, hoping secretly to discover in the beating of their tiny wings some new principle for the design of an improbable flying machine. He liked to mathematical-ize his dreams, and he drew as much pleasure, as it were, from his calculations demonstrating their reality as he did from their doing the opposite—leading to the absurd: he simply loved learning. Once, Tikhonravov decided to design an artificial earth satellite. He read Tsiolkovskiy, of course, and knew that a single-stage rocket could not place a satellite into orbit. He carefully studied works of Tsiolkovskiy's such as "Space Rocket Trains" [Kosmicheskiye raketnyye poyezda] and "Achieving the Greatest Rocket Velocity" [Naibolshuyu skorost rakety], in which the theoretical basis for the idea of a multistage rocket was presented for the first time. But he wanted to try different variations for the combination of these stages and to see how it would all balance out. In short, he wanted to determine how feasible the idea itself was of achieving the orbital velocity necessary for a satellite launched with today's level of rocket technology. He began to calculate and became seriously absorbed in the matter. The Defense Scientific Research Institute in which Mikhail Klavdiyevich worked was studying things incomparably more serious than an artificial earth satellite, but to the credit of his chief—Aleksey Ivanovich Nesterenko—all this extracurricular, half-fantastic work in the institute was not only not persecuted—just the opposite, it was encouraged and supported by Nesterenko, although he did not make a display of it, so as to avoid accusations that he was involved in wild schemes. In 1947-48, without the aid of any sort of computer, Tikhonravov and a small group of his equally enthusiastic colleagues performed a colossal feat of calculation and proved that there did indeed exist a feasible configuration of a rocket package that in theory could accelerate a cargo to orbital velocity.

In June 1948, the Academy of Artillery Sciences was prepared to conduct a scientific session, and a paper arrived at the institute where Tikhonravov was working and inquired about what kinds of reports the research institute could present. Tikhonravov decided to report the results of his calculations on the artificial earth satellite. No one actively objected, but the topic nevertheless sounded so strange, if not wild, that they decided to consult with the president of the artillery academy, Anatoliy Arkadiyevich Blagonravov.

In the company of several of his closest associates, this completely gray-haired 54-year-old, handsome, refined, courteous academician in the uniform of a lieutenant general of the artillery listened very attentively to the small delegation from the research institute. He understood that the calculations of Mikhail Klavdiyevich were accurate, that all of this was not something out of Jules Verne or Herbert Wells. But he also understood something else: that this report would not embellish a scientific session of the artillery academy.

"The topic is interesting," Anatoliy Arkadiyevich said with a fatigued, colorless voice. "But we cannot include your report. Nobody would understand why.... They would accuse us of getting involved in things we do not need to get involved in..."

The high-ranking officers sitting around the president began to nod in agreement...

When the small delegation from the research institute left, Blagonravov felt a bit disturbed. He had worked much with the military and had, by and large, adopted their useful principle of not re-examining decisions once they were made. But he kept returning again and again to Tikhonravov's report, and at home that night he again thought about it. There was no way he could escape the thought that this ridiculous report was in fact not very ridiculous at all.

Tikhonravov was a true researcher and a good engineer, but he was not a fighter. The artillery academy president's refusal upset him. His young associates at the institute, who had held their tongues in the president's office, were now in an uproar, which resulted in, however, new, serious arguments in favor of their report.

"Why did you not say something then?" Mikhail Klavdiyevich asked angrily.

"We must talk with the general again," the youth decided.

And on the next day, they went again to see the general. They got the impression that Blagonravov was almost happy at their arrival. He was smiling, and he listened to the new arguments carefully. Then he said, "All right. We will include the report in the session's agenda. Be prepared—we will blush together..."

The report was given, and afterwards, just as Blagonravov had expected, one very serious individual of no small rank asked as if in passing, as he looked somewhere above Anatoliy Arkadiyevich's head, "The institute must not have much to do and decided to switch to the realm of fantasy?..."

Ironic smiles were more than plentiful. But there were not just smiles. Sergey Korolev went up to Tikhonravov without a smile and, knitting his brow severely, as was his manner, said, "We have some serious things to talk about..."

They had been introduced in the summer of 1927 on Mt. Uzyn-Syrt, near Koktebel, during the Fourth All-Union Meeting of Glider Pilots, and they became friends at GIRD [Group for Study of Reactive Motion], in the basement at Sadovo-Spasskaya. Then their paths diverged. Tikhonravov had been lucky in 1938: he had kept his freedom. And now this new meeting...

Korolev understood the importance of what Tikhonravov had done, and within a year his own work, "Principles and Methods of Designing Long-Range Rockets," would come out. In it he also analyzed the different possibilities of multistage "packaging." But Korolev was a great realist and psychologist. He knew that the technical difficulties of creating a space package of rockets would be great, although surmountable. But he also knew something else: he would have to begin working at once—the difficulties would grow a hundred-fold and would become insurmountable, since we were not prepared psychologically for a satellite. The "cold war" would freeze such a project to the core. One could not talk about a satellite until there was a rocket capable of stopping the nuclear blackmail of the Americans. He began work on the R-3 rocket, which had a range of 3,000 kilometers. That was quite a distance, but still not enough...

Things were worked out with Tikhonravov quickly: he would continue his work. Soon afterward, Mikhail Klavdiyevich conducted an analysis of a two-stage package and proved that it could lift a fairly heavy satellite into orbit. Korolev liked the design: the engine did not have to be started in a vacuum—that had not yet been mastered.

In February 1953, the decision was made to develop an intercontinental ballistic missile. Speculative designs of a huge machine were awash in mathematics, and, just as some kind of contrast appears on a white sheet of photographic paper in a bath with developer, the formulae revealed the contrasts of these designs, their merits, and their flaws. By May, the principal design had been chosen from the two most promising designs—a two-stage ballistic missile and a two-stage missile with a winged second stage. Korolev set to work on the most important business of his life.

A gigantic rocket capable of reaching any point on the globe was needed to defend the country. But Korolev also understood immediately that that very rocket would lift a satellite into space. Tikhonravov was extremely excited: this was a specific rocket, and he knew its specific parameters. If one were to substitute its warhead partly with fuel and partly with the satellite, the rocket would put it into orbit!

On 26 May 1954, Korolev wrote to the USSR Council of Ministers: "The current development of a new product with an ultimate speed of nearly 7,000 meters a second makes it possible for us to speak of the possibility of developing in the near future an artificial earth satellite. By reducing the weight of the payload somewhat, we will be able to achieve the ultimate speed of 8,000 m/sec that a satellite needs..." On 16 July, M.K. Tikhonravov relayed to Korolev a brief report that had been written with I.V. Lavrov: the satellite could weigh between 1,000 and 1,400 kilograms! Two weeks later, on 29 July 1955 [as published], President Dwight Eisenhower published a special communique in the White House that said the United States would begin preparing for the launch of an artificial earth satellite.

The communique created a sensation. Although the Americans had been writing about an artificial earth satellite since 1946, "Eisenhower's Moon," as the journalists dubbed the project, was to once again remind the world of the inaccessible primacy of American technology. The "Bird," as specialists had named the project, was to be the generous gift of a great country to the International Geophysical Year (IGY), which began in July 1957, and would strengthen in the consciousness of millions of people the notion of the indisputable leadership of the United States in the world community. Then, after the launch of our satellite, FORTUNE magazine wrote: "We did not expect the Soviet satellite, and thus it had the effect of a new, technological Pearl Harbor on Eisenhower's America."

But why did they "not expect" it? Did they not know? Why, literally several days after the White House communique, Academician L.I. Sedov, at the Sixth Congress of the International Astronautical Federation in Copenhagen, told journalists that the Soviet Union intended to launch a satellite during the IGY—in fact, several satellites. "It is possible that our satellites will be finished before the American satellites and will be heavier," the academician told them. The president of the USSR Academy of Sciences, A.N. Nesmeyanov, confirmed that, theoretically, the problem of launching a satellite into orbit had been solved. The magazine RADIO published approximate frequencies on which the satellite's transmitter would be operating. S.P. Korolev, in his own report at a gathering celebrating the 100th anniversary of the birth of K. Tsiolkovskiy, came right out and said that Soviet scientists intended to launch a satellite in the near future. Why, much was being written abroad about Soviet satellites. The progressive French science writer Michel Ruze [Mishel Ruze] soberly sized up the situation: "By no means can it be implied that Eisenhower's Moon will be the first to the finish line in the race against its Soviet, and maybe even its English, rivals," he wrote in September 1955.

So why did they "not expect" it? They knew about it and were hearing about it. It was for another reason—they did not want to know, they did not wish to hear. Here once again appeared the long-time American illness that,

alas, remains uncured to this day: for it to admit the possibility of the launch of a Soviet satellite would have been to take a step toward comprehending the actual forces that existed in the world, would have meant admitting that its own assessments of other nations were outdated and were in need of reevaluation. That was something that was beyond the developers of Eisenhower's Moon.

Meanwhile, time passed, and the business of our satellite distressed and alarmed Korolev. At first everything went well. On 30 August 1955, there was a gathering in the office of Academician A.V. Topchiyev, the main scientific secretary of the presidium of the USSR Academy of Sciences: S.P. Korolev, M.K. Tikhonravov, M.V. Keldysh, and, among other specialists, V.P. Glushko. Korolev reported on the status of the operations involving the rocket and suggested that a commission be formed to develop a program for launching a satellite and that the leading scientists of the academy be enlisted to develop the equipment.

"I support the suggestion of Sergey Pavlovich," Keldysh said. "We need to appoint a chairman..."

"You should be the chairman," Korolev replied immediately.

An approximate date was set for the launch—the summer of 1957, the beginning of the IGY. That left 2 years to develop and build equipment, power sources, a temperature-regulation system, a radiotelemetry system with omnidirectional antennae, a system for controlling the operation of the on-board gear, and much more. Korolev immediately recognized the biggest danger: dozens of people were working to solve a single problem. A failure in one link would break the entire chain. Korolev's design office was responsible for the most important thing—the booster, and there still was no rocket. But for the time being that bothered Sergey Pavlovich less than the coordination of all the other operations. Korolev was probably the first to encounter an undertaking of such scale, whose solution required not only his will, experience, and energy, but also the enthusiasm of many other people. It was unrealistic to expect from everyone the enthusiasm he needed and one equal to his. Keldysh consulted with the "atmospheric specialists" S.N. Vernov, L.V. Kurnosovaya, and V.I. Krasovskiy; enlisted his own "apprentice" specialists for trajectory measurements—D.Ye. Okhotsimskiy, T.M. Eneyev, V.A. Yegorov, and M.L. Lidov; got the solar-battery expert N.S. Lidorenko on the job; and advised and consulted with the brightest minds of the academy—P.L. Kapitsa, A.F. Ioffe, B.P. Konstantinov, V.A. Kotelnikov, L.A. Artsimovich, and, among others, V.L. Ginzburg. After the launch of the satellite, Keldysh would say, "Every kilogram of scientific gear was considerably more expensive than gold—it took golden intellects..." But now—and Korolev saw this clearly—they needed fast builders as well as brainy consultants. The schedule for building and testing the equipment was constantly being disrupted.

Finding the guilty parties was difficult: many scientists and many people with higher degrees—creative and original thinkers—turn into downright children when it comes to production. As he spoke with them, Korolev saw that we had little experience when it came to science interacting with industry, that deadlines would continue to be disrupted, and he was nervous about it. He sometimes shared his alarms with Tikhonravov. Mikhail Klavdiyevich would silently nod his head. Korolev interpreted Tikhonravov's placidness to be indifference toward his concerns and was, in any case, completely surprised when, in late 1956, Tikhonravov suddenly suggested this: "What if we make the satellite a little lighter and a little simpler? Thirty kilograms or so, or even lighter?"

Korolev quickly assessed the situation: without dampening the Academy of Science's ardor, and using a few *smezhniki* [suppliers of components] as possible—mainly, Nikolay Stepanovich Lidorenko would provide the power sources, and Mikhail Sergeyevich Ryazanskiy would provide the radio gear—he could use his own resources to build a small, simpler satellite (in the documentation, it is called the PS [original Russian initials for term "simple satellite"]). On 5 January 1957, he sent the government a report which spoke of the preparation of two satellites—one weighing 40-50 kilograms (it would be the first) and one weighing 1,200 kilograms (it would be the third)—and proposed preparing a rocket for launch between April and June of 1957. He got the OK, and on 25 January he signed off on the initial data for the PS.

But there was still no rocket. Or more precisely, there was a rocket, but it had not flown yet. There were many difficulties, but Korolev did not hide them, and in the report to the government he wrote frankly: "The preparatory operations for the first launches of the rocket are proceeding with significant difficulties and behind schedule..." He set the first launch for March. It did not go off. Nor did the launch go off in April. On the 10th of the month, Korolev and the chief control equipment designer, N.A. Pilyugin, went to the cosmodrome. On the way, he said to Pilyugin that he would not return to Moscow until the rocket had flown. The first launch of the R-7 (which is how it is referred to in the documentation concerning intercontinental missiles) took place on 15 May 1957. The rocket did not fly for long: it broke up on the active leg of the trajectory. Pilyugin, the chief launch-complex designer V.P. Barmin, and other specialists left for Moscow. Korolev's favorite—Lenya Voskres (the deputy for testing Leonid Aleksandrovich Voskresenskiy) became ill: his face swelled up horribly, and Korolev sent him to Moscow. Sergey Pavlovich himself was not well. He had a bad sore throat, and they gave him penicillin shots. He never troubled his wife with his worries, but now he was writing Nina Ivanovna letters that were very unlike himself: "When things are going badly, I have fewer 'friends'.... My frame of mind is bad. I will not hide it, it is very difficult to get through our failures.... There is a state of alarm and worry.... It is

a hot 55 degrees here." In mid-June he wrote: "Things are not going very well again!" But he would not have been Korolev if he had not added: "Here, right here and now, we must strive for the solution we need!" On 24 June, his assistant K.D. Bushuyev called from Moscow and said that he had signed off on the drawing of the final configuration of the PS. The satellite weighed 83.6 kilograms. But the rocket still had not flown... In a letter to Nina Ivanovna dated 8 July, Korolev wrote, "We are working hard..." In a letter dated 13 July: "Things are very, very bad..." In all the postwar years, no days were more painful, difficult, or tense for Sergey Pavlovich Korolev than those of that hot summer of 1957. Indeed, he weathered it all with his own "No 7": on 21 August, the R-7 flew! After the launch, he did not go to bed until 3 in the morning, talking about future work and, of course, the satellite. Korolev knew that now No 7 would fly—it had exhausted the inventory of possible failures, such as those that had occurred with the other vehicles, and now it would definitely fly! And it would lift a satellite into space!

Ten days later, on 31 August, after returning from Moscow, Korolev would conduct testing of the PS together with the booster, and in early September he and his designers and testers would send the satellite to the cosmodrome. To the rocket testing site that he would have to rename a cosmodrome.

I had the opportunity to speak with many of those who worked in Korolev's design bureau and with specialists from subcontracting industries about our first satellite. Strangely enough, they do not remember it well. Working on the rocket was so immense and so tense that it pushed that little ball with a "mustache" of antennas into the background of human memory. An assistant of Tikhonravov, Yevgeniy Fedorovich Ryazanov, recalled how the first sketches of the PS were shown to Korolev. Korolev did not like any of them. Ryazanov asked him gingerly, "Why not, Sergey Pavlovich?"

"Because they are not round!" Korolev answered mysteriously.

It was not just that the sphere is an ideal form containing the most volume for the least amount of surface. Perhaps instinctively, intuitively, Sergey Pavlovich was striving for the maximum laconicism and expressiveness of form in this historical device, and in fact now it is hard to imagine an emblem more capacious than this for symbolizing the space age.

Vyacheslav Ivanovich Lappo—the designer of the PS's radio transmitter—recalls how Korolev came to him in the laboratory one night and asked Lappo if we would let him listen to the satellite signals. Lappo explained that the pressure and temperature inside the satellite are monitored by the change in the length of the radio pulses. "Understand, right before it dies, it will squeak a little differently," Lappo said. Korolev liked this very

much. He listened to the "beep-beep" signals with pleasure for a bit, and then he cautiously, even a bit timidly, asked, "There is no way you could make it squeak some sort of word?"

The industrial people who had worked in the experimental plant also remembered more about the rocket than about the PS.

"For us, from the standpoint of manufacturing, it was something truly simple," recalled chief engineer Victor Mikhaylovich Klyucharev. "In fact, all our attention at that time was concentrated on finishing the booster. But for the satellite itself, it was hard to get a shiny surface that reflected the sun's rays: at that time there was no special technology for making the aluminum alloy from which the hull of the first satellite was made. But we mastered that. All who came into contact with the 'little ball' began to literally carry it with their hands, in white gloves, and the stand on which it was assembled was covered with velvet. Korolev, overseeing all the operations involving the satellite, demanded special treatment for that piece."

Yes, fearing that it would be overheated by the sun's rays, Korolev required that the globe of the satellite be polished. He had no idea just how much would be reflected in his mirror on 4 October 1957.

The order for flight testing of the PS was signed at the cosmodrome on 2 October. Leonid Aleksandrovich Voskresenskiy, from the design bureau, and Aleksandr Ivanovich Nosov, from the missile forces, were appointed as heads of the test crews. Early in the morning on 3 October, the rocket was taken to the pad. Operations were going according to schedule, without any hitches.

"Nobody will hurry us," Korolev said. "If you have even the tiniest doubt, we will stop the testing and make the corrections on the satellite. There is still time..."

Did Sergey Pavlovich understand that during these hours the future moral and ethical principles of cosmonautics, unwritten, unnoted in any kind of instructions, were being formed? "No, nobody back then was thinking about the magnitude of what was going on: everyone did his own job, living through its disappointments and joys," Oleg Genrikhovich Ivanovskiy, the assistant to the head designer of the PS, wrote years later in his book, "The First Stages" [Pervyye stupeni].

On the next day, after the rocket had been fueled, Korolev called Khomyakov and told him to go up to the service platform and re-check everything carefully. According to witnesses, the chief designer [Korolev] was reserved and silent during all those prelaunch days, rarely smiling. He continually asked questions of himself for which he could find no answers. He did not know whether the correct trajectory had been chosen, where in fact the atmosphere ended, where its boundaries were.

He did not know if the radio transmitter's signals would pass through the ionosphere. He did not know whether the micrometeorites would spare the polished globe. He did not know whether the seal would keep the vacuum in space. He did not know whether the ventilation system could cope with exhausting the heat. Often now, sometimes without any reason, people use an expression that has practically grown wings—"flight into the unknown." But that was truly a flight into the absolutely unknown, and there has never been anything more unknown in the entire history of man.

It was in the dead of that autumn night, and the launch pad was illuminated by spotlights. It was as if their burning beams made the rocket smoke lightly—the liquid oxygen was steaming. Those on the observation deck saw the white smoke suddenly disappear: the drain valves had been closed, and the tanks were now being pressurized. The "firer" ["strelyayushchiy"] Yevgeniy Ilich Ostashov was giving commands without removing his face from the black rubber that lined the eyepiece of the periscope. Two operators sat at the command console with its buttons during those very minutes: Lt Boris Semenovitch Chekunov and senior technician Anatoliy Ivanovich Kornev. And then the darkness shook, and somewhere below a flame hammered down, and it flashed for an instant from a concrete channel. Columns of smoke and dust engulfed the fire-breathing tail of the rocket for a second, but then the rocket broke away from this hot cloud and lifted upward, flooding the nighttime steppe with light. The satellite was launched on 4 October 1957, at 10:28 p.m. Moscow time.

"We were as happy as kids, laughing and kissing one another," recalled K.D. Bushuyev.

The radio station was set up in a van that was positioned about 800 meters from the pad. A huge crowd of people packed into the van, everyone wanting to hear the voice from space. Slava Lappo sat at the receivers and recorders and waited for the signal. And suddenly he heard something that was at first distant and weak but that became increasingly louder and clearer: "Beep-beep-beep..." A hearty "Hurrah!" arose, drowning out the happy voice of Ryazanskiy, who was yelling over the telephone to Korolev, who was in the command bunker: "We have it! We have a signal!"

On its first revolution (it lasted 92 days in all), the ballistics specialists established that the satellite was losing little altitude, but to be safe the State Commission chairman Vasilii Mikhaylovich Ryabikov decided to wait until the second revolution to call Moscow with a report. Seeing as it was in the middle of the night in Moscow, everyone was asleep...

No one noticed that it was already daylight. The first morning of the space era had come to the planet Earth.

Thousands of articles, entire libraries of books will be written about that night. The launch of the first satellite will be analyzed from every angle: the scientific, the technical, the historical, the social, the political. It will force us to look at many of the problems of our age in another light.

But to speak today only of the political significance of that launch as it applies to events 30 years old would be to belittle the event. Is it not symbolic that the most horrible of all the weapons that existed at that time—the intercontinental ballistic missile capable of carrying an atomic warhead—barely out of the womb, was transformed, in a matter of literally just a few weeks, into the most powerful instrument for science? The NEW YORK HERALD TRIBUNE, as if with surprise, wrote then that "in spite of the obvious psychological victory of the Soviet Union, this will not lead to an intensified threat of the outbreak of war." The launch of 4 October 1957, was not only the most graphic, convincing demonstration of the scientific and technical potential of the Soviet Union, but also new evidence of its peace-loving policy.

The satellite delighted the specialists—that is understandable. But it also brought delight to people who had absolutely nothing to do with science and technology. They saw the marvel of human thought and effort in this man-made object that was hurled upward and did not fall back to earth. The Soviet satellite forced all the inhabitants of earth to be proud of themselves—that is the principal result of its triumphant flight above the planet.

Thirty years have passed. Already 30 years. Just look at how time flies! But it is still just 30 years! And look how far we have already traveled along the highway in space! But no matter how far we go, no matter how small that shiny globe seems to us in the distance of years gone by, it will always shine to all those who are traveling to the stars, because we endowed it with a greatness that can never be surpassed by anyone: it was the very first!

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Interview With Lt Gen Shatalov, Head of Cosmonaut Training Center

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[Interview with Lt Gen Avn. Vladimir Aleksandrovich Shatalov by B. Kononov: "Why the Road to the Stars Is Thorny"; first paragraph is NEDEL'YA introduction]

[Text] Lt Gen Avn. V. Shatalov, head of the Cosmonaut Training Center imeni Yu.A. Gagarin, twice Hero of the Soviet Union, tells IZVESTIYA science reviewer B. Kononov about the difficulties of establishing a new profession.

Question: Vladimir Aleksandrovich, 26 years have passed since Yuriy Gagarin's flight. But the cosmonaut profession is still not a large one. It is moving forward at a pace that is strikingly different from that of other professions that were unique in their own time, professions such as pilots, submariners, and polar explorers. What is the reason for that?

Answer: It has to do mainly with the unusualness of the world to which mankind has come. Essentially, space has no terrestrial analogs. Practically from the beginning, for example, polar explorers had to have warm clothing and stores of foods, and they had to accustom themselves to the cold. Man is a flexible creature, and that flexibility is comparatively easily achieved. Recently, for example, an American sportswoman swam the 4-kilometer width of the Bering Strait, where the water temperature was only 7 degrees, in just a bathing suit. Right now, an international group of skiers headed by D. Shparo are preparing to cross the Arctic Ocean, from the shores of the USSR to Canada, on skis. And for that, they need do only this—equip themselves and train. But do you think there is any training you can undergo to accustom yourself to a vacuum?

People learned to breathe underwater through a reed tube as far back as ancient times. The first submarines were made with the most primitive of means. In exactly the same way, enthusiasts were able to build the first airplanes with their own hands. So, things developed in different countries and at rapid rates. This was predetermined by the comparative simplicity of the technology needed for breaking through to the underwater world and to the ocean of the sky.

Space, however, has required a totally different level of technology. First, it is expensive: for every kilogram of payload hurled into space, you need 30-40 kilograms of launch weight on the ground in the rocket. Second, it is very complex. If it were just a matter of money, then probably the people of many countries could easily pool together to put their own cosmonaut into orbit.

From the very beginning—the launch of the Soviet satellite—space equipment has required the highest level of scientific developments and design implementation and the most advanced technology. And a problem could not be solved by the enthusiasm of one person, as with the mastering of the submarine ocean or the ocean of the sky. Success in space took government expenditures; a colossal collective effort by scientists, engineers, workers; and a general industrial level that was very high. An indication of how serious this barrier is, is the fact that even developed European countries and Japan, who have long had first-class submarines and aircraft, are still technically unable to independently launch their own cosmonauts into near-earth space.

There is yet another obstacle, this one laid like a "delayed-action mine" in the nature of man himself. Millions of years of evolution have adapted us to earth's

gravity. Aboard a submarine or an aircraft, one is not torn from the earth's hold. The vehicle's walls and life-support systems are enough to isolate us from the new world, and in it we will feel essentially the way we feel on the ground. But no kinds of walls can spare us from the effects of space: there man finds himself in weightlessness. He is suddenly deprived of the customary gravity. And he must immediately pay for that. Independent of the cosmonaut's will, of his consciousness, his body begins to readjust, to adapt to the new conditions. This is not an easy process or one without pain. And you will find nothing similar to it in normal earth-bound existence. For that reason, man plumbs the depths of weightlessness very carefully.

Question: The Soviet cosmonauts L. Kizim and V. Solovyev, as well as O. Atkov, established the record for remaining in weightless conditions—237 days. V. Ryumin spent nearly a year in orbit with only a small interruption. Now Yu. Romanenko has surpassed the continuous flight record. Is there, in your opinion, some kind of optimal period for remaining in space? What do you think the next developments in cosmonautics will be? Is a flight to, say, Mars and back possible?

Answer: The medical people are cautious in their evaluations. A serious hurdle that they feared, for example, was the 120-day flight. It takes that amount of time for all the blood in the human body to renew itself. The medical people initially feared that the conditions of space flight could have an irreversible effect on the work of the blood-producing system. That did not happen. On the record flight, the cosmonauts went through two cycles of blood renewal, with no effects. Therefore, we can take the next step in increasing the duration of flight. An experiment in which the mobility of individuals was kept at a low level for a year, simulating to some extent space flight, was conducted at the Institute of Medical and Biological Problems of the USSR Ministry of Health. The individuals withstood these conditions without any ill effects on their health. So, apparently, a yearlong flight by a cosmonaut is something that is practical.

The flight to Mars and back would take 2 to 3 years. This is another matter entirely. And at this time, no one will venture an answer as to whether or not it is possible, from a medical standpoint, without the use of equipment that would simulate gravity.

As regards the optimal durations a cosmonaut can spend in near-earth orbit, there are various points of view. Economically speaking, lengthy flights are more advantageous, since launching cosmonauts into orbit is not inexpensive, and it makes sense to get as much out of the launch as possible. One must bear in mind that it takes a certain amount of time to adapt to weightlessness, and the cosmonauts' efficiency is reduced; it also takes time for them to "feel at home" in the station and to become accustomed to working conditions in space. Experience shows that the longer the flight, the higher the "output"

of the cosmonauts as operators and researchers. There has not been a single crew that would not say that it could do twice as much after a month than at the beginning of the flight. But, of course, a lengthy stay in a confined space, away from your family and everything you are used to, has its effect. Fatigue gradually sets in. True, we have yet to observe a sharp drop in efficiency by the end of a lengthy flight, but there is a definite reduction. And that has to be taken into consideration. In my view, under the current conditions, a flight of about 4 months is the optimum in terms of the maximum "output" of a cosmonaut. Maybe as much as 6 months is reasonable.

Of course, the logic inherent in the development of cosmonautics, as we already mentioned, requires very long flights. The "reconnaissance in force" of living in weightlessness will continue. I think that space medicine will determine what the safe limit is for a person to remain in weightlessness at the current level of our technical resources. The optimum duration, obviously, must be beneath that limit, but by how much depends on the specific goals of a flight.

Twice already we have partially rotated crews. This practice will develop further as one of the possible variations for combining very long flights with optimal durations. In the future, apparently, stations will have to be manned continuously. Cosmonauts will begin to replace each other, handing "business" over directly in orbit.

Orbital stations will, indisputably, be the primary means of developing near-earth space. American specialists are also leaning in that direction. They intend to create a long-term orbital station in cooperation with Western European partners in the mid-1990's. We have already garnered a great deal of experience in that area of activity. Right now, the orbital station Mir is in space—a third-generation representative of Soviet space vehicles of that kind. Its primary distinguishing feature is its six docking ports. (It will be recalled that the previous generation of stations—Salyut-6 and Salyut-7—had two ports each.) A new feature allows so-called special-purpose modules to dock with Mir. One of them—the Kvant—is moored to the station's stern docking port. Kvant was designed primarily as an astrophysical laboratory for studying the universe in the X-ray and UV ranges. But this module is special. In essence, it lengthens the Mir station. Manned vessels and freighters can be moored to the Kvant's stern docking port, and people and freight board the station through opened hatches. Fuel is pumped from Progress freighter vessels to Mir's tanks through Kvant. Other special modules must moor to Mir's forward docking port. Later, a manipulator will automatically transfer them to one of the four side docking ports. These modules can be designed for the most varied of purposes, such as for doing medical and biological research, for studying the ocean or performing remote sensing of the earth's surface, or for producing new materials or valuable preparations on biotechnical units.

Mir will carry out the fundamental tasks as the base unit which controls the entire complex and which is where the cosmonauts live. There are two individual cabins here for the main crew. But, frankly speaking, living conditions for the cosmonauts are, for the time being, more difficult than, say, those aboard a submarine. Comfort in orbit will be increased and the options for research will be expanded with the new Soviet rocket Energiya, which is capable of putting a station weighing more than 100 tons into orbit. That is five times the weight of the Salyuts or the Mir, which were placed into orbit with the Proton rocket, which has served our space program since 1965.

Question: Judging from what you have said, medicine is not going to lower the standards for the cosmonauts. When, in your opinion, will scientists who do not have perfect health be able to work in space?

Answer: Yes, for now the health requirements for cosmonauts remain quite strict. This is due mainly to the fact that medicine is still unable to predict with sufficient accuracy the possible effects spaceflight will have, especially the long-term effects. Spaceflight statistics are still few. And everyone responds differently to flights. Other conditions being equal, naturally, a healthy individual will endure space well. For that reason, in the selection process, out of 50 pilots who are unquestionably fit for flying jet aircraft, often only one will pass the health test to become a cosmonaut.

But even that, as experience recently showed, is still no guarantee. Tests on the ground showed Aleksandr Laveykin to be absolutely healthy, and there were no indications to the contrary. But on board, during a long flight, in tests on a bicycle ergometer when the physical exertion is specialized, cardiac rhythm abnormalities were detected in him at certain times. The medical personnel could not give 100 percent assurance that continuing the flight would not injure his health. In order not to risk that, we had to take the opportunity to return him to earth with the Soviet-Syrian crew that had just arrived on Mir. Thus, the strictness of the selection process is necessary "insurance." And that is how it should be. If you look at all the generations of cosmonauts, you will see that the overwhelming majority of them maintain good health even as they grow older, which enables them to make new flights, using the experience they acquired in the earlier flights. V. Dzhanibekov, for example, has been in space five times!

On the other hand, allowances have to be made for the probability of unexpected situations during a flight, when conditions considerably different from the usual can crop up. There was, for example, the time when a booster failed on the active leg of the trajectory. The emergency rescue system for the cosmonauts was activated, and they landed safely. There was a fire during one launch. The emergency rescue system worked smoothly then, too—the spacecraft was "shot away" immediately, the solid-fuel engines took it off to the side

and up, and the parachute opened—and everything ended all right. But the cosmonauts underwent a g-load of 15-17 during the whole thing, not to mention psychological stress. Only a physically healthy and trained individual can withstand something like that. For that reason, I do not think the medical requirements will be lowered in the near future. But that does not mean that specialists cannot fly: healthy individuals can be found among them, too. The physician O. Atkov, for example, spent 237 days in space. There is no reason we cannot select and train, say, a biologist, an astronomer, a geologist, or an oceanologist. In my opinion, it is totally feasible.

In the more distant future, with the use of the Energiya rocket, the design of spacious, roomy stations and spacecraft, and the development of new safety systems, it would seem that a clear division will be made between crew and scientific personnel, like the division that is made, for example, on sea-going scientific-research vessels.

There will be an organization like, shall we say, Aeroflot, which will run permanent Earth-Space-Earth flights, whereas scientific organizations will select specialists for work in space. Changes in space technology will result in changes in the medical requirements for scientific personnel, which, of course, will have to be less strict than those for the professional cosmonauts.

Question: But for now, is the basic premise in training the fact that the cosmonaut must be versatile—both a pilot and a researcher?

Answer: The goal assigned the cosmonaut in the beginning of his training is no different than what it was in Gagarin's time: to be able to carry out the entire flight mission. The mission itself, however, has of course become more complicated over the years. The equipment has changed. Why, we have automatic equipment, which, in routine conditions, makes the work of the cosmonaut substantially easier. But in situations that are out of the ordinary, you have to switch to the back-up, manual controls. There have been many such instances in flight. Consequently, on the ground, at the Training Center, the crew must know perfectly the ship, the station, and how its systems operate. A cosmonaut must be able to locate a malfunction immediately and find a way out of a complicated situation.

On the other hand, the volume of research is constantly expanding. Members of the two- or three-man crew must, whether they like it or not, be versatile—they must be able to conduct experiments involving areas such as astronomy, geophysics, medicine and biology, and engineering. Naturally, a cosmonaut will not be as proficient as, say, a professional astronomer. But he must know the instrumentation and the essentials of the processes that take place during an experiment, and he must be able to adjust the original program if necessary.

Question: And how long does it take for a newcomer to become a professional cosmonaut?

Answer: Right now, it takes 3 to 5 years for that. During that time, we try to make it so that a future cosmonaut will be a back-up, sometimes more than once. Often, you may hear that that is, they say, "mental trauma." An individual is trained as an equal, but someone else goes on the flight. No, that is part of the training, and a very important and responsible part, and the overwhelming majority of us understand the situation quite well.

Question: Tell me, how do you explain the fact that, lately, crew commanders also have been undergoing training in test-pilot school? And why up to this time has anyone who has been in orbit been called a pilot-cosmonaut of the USSR?

Answer: That is not a simple question. Do not forget that, for all that, cosmonauts make up a profession that is still not very large, but is unique. And the training involved is often "individualized." Why, now we already have stratification of specialties—the commander, the flight engineer, the cosmonaut-researcher, the cosmonaut-tester, the physician-cosmonaut. But I want to emphasize that we train all of them to pilot the spacecraft and the station. And this combination of specialties is for the time being vitally necessary. If the commander suddenly became ill, the flight engineer, for example, would have to land the spacecraft on earth by himself.

The term pilot-cosmonaut, therefore, is a general term. All Soviet cosmonauts who go into space are prepared to assume the role of pilot. These two professions share a great deal. Pilots and cosmonauts both must undergo g-loads, must work in high-altitude suits, must know how to get their bearings from the earth at high altitudes, must operate a multitude of instruments. A characteristic feature of a cosmonaut's working conditions is the rapidity of many of the processes he must deal with and the lack of time to make a decision. Quite often, it is not possible to consult with the Flight Control Center. If you recall that a spacecraft in near-earth orbit travels at a speed of 8 kilometers a second, and neurosignals in a human being travel at 50-60 meters a second, practically 150 times slower, that will give you some idea of how important it is for a cosmonaut to develop fast reflexes. Because of that, automatic equipment is being used more and more on spacecraft. But, I repeat, the cosmonaut must monitor the operation of that equipment and must intervene quickly if need be. This is especially important during launch, during docking, and during landing.

I remember how the American astronaut David Scott was showing me the turbojet with which they were training for a landing on the moon. We had just examined the excellent simulators that provide good ground-based training with conditions similar to the real conditions. And yet it was a capricious, unstable machine. We

already knew that not long before our arrival, one of the engines in the turbojet had malfunctioned, and the astronaut had been forced to eject.

"Why do you have such flights?" I inquired, already knowing the answer, but wanting to get confirmation. "Are you not risking your life?"

"That is the point," Scott answered. "Here on the ground we can stop the process at any time, and sit down and think about it. But any kind of a mistake in the sky means the end of the turbojet. The pilot has just one chance to save himself—eject and parachute. At the same time, he understands quite well that he will not have that chance on the moon. And that changes his approach to ground training. He gets into the simulator with a different frame of mind—the feeling of responsibility for performing irreversible operations grows sharply."

The primary responsibility in the performance of dynamic operations falls on our pilot-commanders. Test-pilot school pursues that same goal—teaching them to take responsibility for their actions, to be fearless, and to be cool-headed. Emergency situations are purposely set up, and the individual learns to not lose his head and to act with precision, in a collected manner, and correctly. I would like to emphasize that flight training is important for all the professions that go into space. The individual must be trained to deal with stress, to be responsible for what he does. Individuals are not born fearless, they become that way.

Question: You have "sung" a veritable hymn for flight training. But apparently, as head of the Cosmonaut Training Center, you devote no less time at least to ground training. What is new that has come about in recent years?

Answer: Naturally, ground training is the most important thing in the preparations. Many of the techniques have not changed—that is, training on the centrifuge, on the vestibular units [vestibularnyye stendy], and in the isolation chamber; flights with short-term weightlessness; and physical training. The creation of conditions that are closer and closer to the real thing is characteristic of the units that simulate the spacecraft and the station.

When the time came for cosmonauts to make constant working excursions into open space, we developed a special water-laboratory in which an orbital station could be totally immersed into a pool and, with the help of special devices, weightlessness could be simulated in the water. Crews could learn to conduct any kind of operations outside the station. The operations that crews are learning to perform are becoming more and more complex, for example, the assembly of new solar battery panels.

Something new that space life has introduced is the "douchivaniye" [completion of education] of the crews in flight. When a flight lasts 6 months or more, you cannot foresee everything that will happen. Could anyone, for example, really have guessed that some kind of foreign body would get into the docking port between Mir and Kvant and interfere with the coupling of the two space vessels? In the water-laboratory, we modeled the situation that had arisen, and then we relayed recommendations to the crew aboard the craft, and then, in accordance with our instructions, Yu. Romanenko and A. Laveykin acted on their own and corrected things, although they had not been prepared for this when they were on the ground. The expensive Kvant module, in which Soviet scientists and many foreign scientists had invested 7 years of work, was not lost and still serves our space program today.

But this is an extreme case. In the course of a lengthy flight, a whole series of simpler situations arise. The program has been changed, some new research must be done, an instrument must be recalibrated... And in that case, we use the existing channels of communications—radio, teletype, television. Freighter vessels sometimes deliver video cassettes on which entire lectures, with detailed instructions for the crew, are recorded.

A flexible system of training, which includes elements of the on-board "douchivaniye," requires that the Cosmonaut Training Center maintain closer contact with the Flight Control Center and the scientific institutions. Thus, our duties include not only preparations for the flight, but also continued tracking of it.

Question: I remember that when you flew on Soyuz-8, they gave you a tool that was to be used for the first time on board. Before that, they felt that space gear did not require repair...

Answer: The tool was a screwdriver that could also be used to chisel. And it turned out that we had to fasten one of the parts of the control stick. That required cutting away an angle piece that was in the way. I "pecked away" for a whole hour. Until A. Yeliseyev began to cry, "Not so methodically—the solar battery panels are going to break off." Then I bandaged it all with friction tape—it came out like a prosthesis. Now that stick lies somewhere, a monument to the first repair operations.

And then experience showed that there is practically no system that does not require repair in space. Designers introduced new concepts—the reparability of a system and the accessibility of repair. And that is understandable. The first Soyuzes flew several days. But the, say, Salyut-6 was in orbit for 5 years. A lot can happen over that period of time.

Some of the most complicated situations can arise, like the restoration of a "dead" station to working order. V. Dzhanibekov and V. Savinykh, for example, docked

with the disabled Salyut-7 and heroically worked there in sub-zero temperatures. After they revived the station, they carried out an extensive program of research.

Of course, repair operations require skills and timely training. A cosmonaut must now be able to use a file and a clamp, must be able to solder, rivet, drill, and saw, must be on intimate terms with bolts and nuts, and must know electronics well.

Question: Vladimir Aleksandrovich, does it not bother you that a great deal of the crew's time in orbit goes to "self-service"? Someone calculated that, for now at least, a crew spends only a small fraction of its working day on research and experiments, whereas the bulk of its time is spent on such things as keeping the various systems of the station in working order, physical exercise, talking with earth, and medical examinations.

Answer: Yes. We have options here, a great many. A great deal depends on the improvements made in space equipment. The idea of relieving the crew and freeing it from auxiliary operations can be clearly traced in their development. As much as possible is gradually being transferred to the shoulders of electronic and computerized equipment and automatic complexes.

If you recall, say, the first 10 years of manned flights, all commands and changes in the operational program were relayed by voice by operators on the ground. The cosmonauts wrote them down and confirmed them. All this took a great amount of time. There were whole volumes of documentation on board. You had to "rummage" through them to find the page you needed. The Mir station is already rather well equipped with computer equipment. The automatic equipment for controlling the orbital complex has been set up, and automatic control of all the systems is carried out both on board and from the Flight Control Center. The flight program and its changes are relayed by command radio link to the computers' memories. The on-board computers operate in service mode, and everything that the crew must do on each orbit of the flight lights up on the display screen.

All diagrams, instructions, and recommendations that used to be logged in the volumes of "on-board documentation" are now "protected" in the computer's memory, and the computer issues the crew everything it needs if an emergency arises and requires the intervention of the cosmonauts or if it simply needs their help in performing a task. Communications between the cosmonauts and the Flight Control Center can now be carried out via satellite. The Mir station, for example, is testing a special narrow-beam antenna that remains aimed at the satellite during the flight and maintains communications with the cosmonauts on a considerable portion of each orbit.

For now, it is an experimental operation. But in the future, when a system of two or three geostationary satellites that are in communication with each other and with earth is operating, it will be possible to maintain

practically round-the-clock communications between space crews and the Flight Control Center. This will enable us to relieve ground stations of a considerable amount of the flight tracking they do. But mainly, it will be possible to continuously monitor everything that is happening on board on any orbit and relay commands when necessary. Such communications will have a substantial impact in terms of improving the psychological environment aboard a spacecraft. Just knowing that you have constant contact with earth means a great deal.

No matter how we combine the "blocks" of the everyday program, the program and life itself aboard a spacecraft remain rather monotonous. You have the same equipment, the same control panels, the same globe, which, as it turns out, is so small that after just 2 weeks of the flight, you can easily orient yourself without a map. And in those circumstances, the alternation of work and rest is very important. Rest on board, however, is for now the Achilles' heel of the flights. Yes, good libraries are needed, as are good inventories of videotapes and audio tapes and regular videotaped meetings with family. Sometimes you need to be alone in your cabin. When the stations are improved, options for rest will be expanded.

But it is very important to move from today's psychological support of the crew—which, whether we like it or not, is poor—to unceasing psychological contact between the cosmonaut and earth. In my opinion, it is more important for the cosmonaut to see the Vremya broadcast at its customary time than to see the most wonderful videotapes. It is more important to be able to call home at any time than to have specially organized Sunday contacts with the family. All this taken together is now called the "human factor." On lengthy flights, for example, it plays an extremely important role in boosting the work that is done in orbit. I think that we are still not giving this enough attention. Of course, better equipment is the most important thing here, but we can still do a lot without it.

Overall, I think there is a lot left to do not only in terms of psychological support of the normal activity of the crews, but also in terms of the medical support in general. I will give you my own personal opinion, which the medical authorities may not agree with. There has long been talk among the cosmonauts that so far our medical profession is exploring ways to protect against weightlessness on too wide a front. And the main thing is that all this up to now is only as an experiment. It astonishes us that no matter how many crew members there are—two, three—they all use everything the medical profession places at their disposal to preserve efficiency during weightlessness and in the period of readaptation. It seems it would be more sensible to propose one technique for one cosmonaut, and a different technique for another cosmonaut, and then compare the two and draw conclusions. No—everything is "piled together," and it is impossible to determine what is more effective and what is less effective. Hence, it is mandatory for all cosmonauts to do a great deal of physical exercise on a

treadmill and a bicycle ergometer and a great deal of work with stretch cords. Besides that, the wearing of pressure suits [nagruzochnyye kostyummy], the presence of a vacuum tank, and medicinal preparations. But again, it is not clear what of all this is the most effective. And exercise takes a lot of working time.

When you as much as mention this, they usually remind you that after a 14-day flight on the Gemini spacecraft, one of the American astronauts broke his leg, so brittle were his bones. They bring up the difficult readaptation A. Nikolayev and V. Sevastyanov went through after an 18-day flight on the Soyuz-9. But the spacecraft back then were very cramped, and it was really hard for cosmonauts to move around. Orbital stations are a totally different thing. Crews now are constantly moving, repairing something or doing some kind of physical labor. That has to be taken into account. The Progress vessels arrive on a regular basis. In space, mass is still mass, and unloading the "trucks" and putting spent equipment into them is heavy work. By their own admission, the cosmonauts get very tired. And then go push some pedals or walk, like clockwork, on a treadmill. That gets to be very tiringly monotonous, and mainly, you begin to wonder the whole time: Is all this physical exercise necessary?

Nobody is arguing with the fact that these things are beneficial, but you and I would not spend 2-3 hours a day during working hours doing exercise, although it would not do any harm. But we have to get our work done. And it seems apparent that a necessary minimum of physical exercise must be determined, so that it can be performed with pleasure and will not take up so much work time. Everything is fine in good measure. And that measure should be scientifically established on every flight, individually for each cosmonaut.

Question: Vladimir Aleksandrovich, are you satisfied with the "yield" today's manned flights have for the economy, or are you dissatisfied? One always has to promise journalists, for example, that this will give the economy something, or will help it, or will prompt something. Is it not time to convert the future to the present?

Answer: Some areas of activity, such as aerial survey from orbit, for example, have practical applications. But on the whole, of course, there is no singleness of purpose, no consistency. In my opinion, the sweep is unsystematic, with a set of experiments aimed in the most varied of directions. We do not have a good program with a clearly defined set of goals and a step-by-step means of achieving them. Apparently, this is due in some degree to the general state of our country's science, which interacts poorly with the economy and deals little with practical needs. At the same time, much is being done in orbit right now that can have no small effect on the economy. But crews bring findings back to earth, and it is as if it all sinks into some chasm. Maybe expansion of the functions of the recently created Main Space Administration

of the USSR [Glavkosmos SSSR] would improve things. Of course, flights into space, for the most part, represent travel into the unknown. And theoretical assumptions often part with the practical. That is what happened, for example, with space technology. It turned out that there is no pure weightlessness aboard a spacecraft, but that conditions of microgravity reign. It was ascertained that the effect of certain physical phenomena had not been presented absolutely clearly. And that, to a certain degree, slowed operations down.

But much could be changed if we did not have to wait the results of this or that experiment to be delivered to earth once every 6 months. Descent capsules could be used for timely delivery of the needed materials from the spacecraft. We tried that before, but for some reason we have forgotten it. As it is now, we wait for 6 months in orbit. On earth, we do research for 6 months or a year, and then we prepare the next experiment. At this rate, we will not make it by the year 2000 to the orbital shops and factories whose creation the press has in fact promised many times. Earth-bound technology, on the other hand, is not standing still all this time and is constantly improving. Just look—what seemed economically feasible in space just yesterday is already done on the ground with means that are comparable in cost.

We are placing a great deal of hope on special modules that will work in conjunction with the Mir station. Maybe we should convert one of these modules into capsules that can be sent periodically to earth with experiment results. To a man, all the crews confirm that knowing the importance their work has for the country gives it sense and makes it easier for them to endure the lengthy stay in space. If they know while they are still in orbit that the fruits of their labor are being used, that, like nothing else, will give the cosmonauts some encouragement.

But our space program is, in general, still young. And the current shortcomings are the "costs" of the youth of the space industry. We should not forget that right now we are marking only the 30th anniversary of the beginning of the space age that was opened up by our first satellite.

Question: Tell me, please, what kind of features did the international flights introduce into cosmonaut training? We have a wealth of experience: the Soviet-Syrian crew was already the 12th international crew.

Answer: Crew, yes. But for us, that was the 13th international flight. Much of the foundation of our international training was laid during the first flight—in the Soyuz-Apollo program. Based on that experience, we were then able, without any effort and without much restructuring, to start, you might say, regular training of international crews at Zvezdnyy Gorodok for flights on Soviet spacecraft and orbital stations. When the crew consisted of two cosmonauts, special emphasis was placed on the duties of the flight engineer during the training of the representative of the foreign nation. In

three-seater spacecraft, these duties tapered off. A foreign cosmonaut-researcher is responsible for communications, television, and the normal operation of the Soyuz life-support systems.

Of course, the most important thing for them all has been and remains their national program of research, which is prepared jointly with us. But we definitely familiarized and continue to familiarize the foreign cosmonauts with the spacecraft's and the orbital station's equipment, so that they will be aware of all the processes that take place there. They tell us that foreign astronauts training on the American Space Shuttle craft have absolutely nothing to do with that side of things. They work only with the instruments of their own country.

Question: The cosmonaut profession is nevertheless becoming more popular. What, in your opinion, is its most characteristic feature? What is its core like?

Answer: In my opinion, the core of our profession lies in its extremely high degree of responsibility. The labor of thousands of people, of large groups, and often not just one country, depends on the reliability of the cosmonaut's work. He must bear this burden of responsibility without straining, he must remain simple, happy, good, attentive to those around him—in a word, he must be a good person, with whom everyone can work.
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Soviet-American Space Working Groups Meet in Moscow

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INDUSTRIYA in Russian 8 Dec 87 p 4

[Text] A conference of a joint Soviet-American working group for research of the solar system has opened in Moscow. This conference is being conducted within the framework of an agreement between the USSR and the USA in regard to cooperation in the peaceful study and use of outer space.

The delegations consist of representatives of the "Inter-cosmos" council of the USSR Academy of Sciences and the U.S. National Aeronautics and Space Agency, and leading Soviet and American scientists.

"We shall discuss coordination of scientific research and exchanging of data that are obtained, for the purpose of studying planets of the solar system, particularly Mars and Venus, and also cosmic dust, meteorites and lunar soil," said V. Barsukov, corresponding member of the USSR Academy of Sciences and head of the Soviet delegation. "An agreement which was signed in April of this year calls also for specialists of the two countries to take part, by mutual agreement, in a number of projects which the sides are carrying out. It is significant that the present conference is taking place at the time of the meeting between M.S. Gorbachev, general secretary of the Central Committee of the Communist Party of the Soviet Union, and R. Reagan, President of the United States. This is symbolic of possibilities for further cooperation between the two countries in the peaceful study and use of outer space."

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